K-12 SCIENCE EDUCATION VISION

A K-12 Dublin City Schools science education engages *all students* in critical thinking and problem solving as they experience science and engineering. We believe that students can become scientifically literate citizens equipped with the knowledge and skills demanded by the ever-changing future, whether in the workforce or higher education.

We believe in developing our learners through high quality experiences that include:

- A challenging, collaborative and inquiry based environment.
- Opportunities to solve and investigate real-world problems that require critical and global thinking.
- Opportunities for students to build an identity as a scientist, able to interpret the natural world, participate productively in scientific practices and contribute to society in meaningful ways.
- Opportunities to research, generate and evaluate evidence and explanations that uphold or refute scientific data.

We believe these learning experiences will grow independent, confident students who will become creative, innovative adults that are capable of using informed scientific judgement to improve their world.

Instructional Agreements for Science Learning within the Dublin City Schools

1. Learning goals will be communicated to guide students through the expectations of science learning using a variety of instructional techniques and technology integration.
2. Teachers will ensure a safe, challenging learning environment focused on inquiry and science exploration.
3. Teachers will provide support to students as they learn to frame questions, assess and analyze data, and create and critique explanations – all important components of scientific and engineering practices.
4. Content standards will be learned in partnership with Ohio’s Cognitive Demands for Science, Science and Engineering Practices and Nature of Science practices.

Nature of Science	
One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.	
Scientific Inquiry, Practice and Applications	All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.
Science is a Way of Knowing	Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.
Science is a Human Endeavor	Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.
Scientific Knowledge is Open to Revision in Light of New Evidence	Science is not static. Science is constantly changing as we acquire more knowledge.

Scientific and Engineering Practices:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Ohio's Cognitive Demands for Science	
Cognitive Demand	**Description**
DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	Requires students to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.
DEMONSTRATING SCIENCE KNOWLEDGE	Requires students to use scientific practices and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments. (Slightly altered from National Science Education Standards)
INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	Requires students to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.
RECALLING ACCURATE SCIENCE	Requires students to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.

GRADE 5

Grade 5 Course Goals:

Students in Grade 5 will focus on exploring the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry. Students will learn about the cycles and patterns in the solar system and light, sound and motion and interactions within ecosystems.

Strand Connections:

Cycles on Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. Speed is a measurement of movement. Change in speed is related to force and mass. The transfer of energy drives changes in systems, including ecosystems and physical systems.

EARTH AND SPACE SCIENCE (ESS)	
Topic: Cycles and Patterns in the Solar System This topic focuses on the characteristics, cycles and patterns in the solar system and within the universe.	
Content Statement	**Content Elaboration**
5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics. The distance from the sun, size, composition and movement of each planet are unique. Planets revolve around the sun in elliptical orbits. Some of the planets have moons and/or debris that orbit them. Comets, asteroids and meteoroids orbit the sun.	Planets in the solar system orbit the sun. Some of the planets have one or more orbiting moons. Earth is a planet that has a moon. The moon orbits Earth. Gravitational forces between the sun and its planets cause the planets to orbit the sun. Gravitational forces between a planet and its moon(s) cause the moon(s) to orbit the planet. If no forces were present, planets and moons would continue their motion toward outer space without changes in speed or direction. However, gravitational forces between the sun and each planet continuously changes the planet's direction so it remains in orbit. In the same way, gravitational forces between each moon and its planet continuously changes the moon's direction so it remains in orbit. Asteroids are rocky bodies that orbit the sun in nearly circular orbits but are too small to be classified as planets. Comets are a mixture of ices (e.g., water, methane, carbon monoxide, carbon dioxide, ammonia) and dust, and have highly elliptical orbits. A meteor appears when a particle or chunk of metallic or stony matter called a meteoroid enters Earth's atmosphere from outer space. Meteors that pass through the atmosphere and impact Earth's surface are called meteorites. General information regarding planetary positions, orbital patterns, planetary composition and recent discoveries and projects (e.g., missions to Mars) are included in this content. Tools and technology are an essential part of understanding the workings within the solar system.

5.ESS.2: The sun is one of many stars that exist in the universe. The sun appears to be the largest star in the sky because it is the closest star to Earth. Some stars are larger than the sun and some stars are smaller than the sun	The sun is the closest star to Earth. Scaled models (3-D or virtual) and graphics can be used to show the vast difference in size between the sun and Earth. The sun is a medium-sized star and is the only star in our solar system. There are many other stars of different sizes in the universe. Because they are so far away, they do not appear as large as the sun. Stars appear in patterns called constellations, which can be used for navigation. General facts about the size and composition of the sun are introduced. Details (e.g., age of the sun, specific composition, temperature values) are above grade level. The emphasis should be on general characteristics of stars and beginning to understand the size and distance of the sun in relationship to Earth and other planets. Current and new discoveries related to the sun and other stars are included.
5.ESS.3: Most of the cycles and patterns of motion between the Earth and sun are predictable. Earth's revolution around the sun takes approximately 365 days. Earth completes one rotation on its axis in a 24-hour period, producing day and night. This rotation makes the sun, stars and moon appear to change position in the sky. Note: Moon phases should not be the focus	In a day Earth rotates once on its axis, which is tilted at a 23.5° angle. Earth's rotation causes the apparent position of the sun, moon and stars to move in the sky from east to west. Some stars are visible from all parts of Earth, some stars can only be seen from the northern hemisphere and some stars can only be seen from the southern hemisphere. Stars located directly above the north and south poles do not appear to move. A well-known example of this is the North Star. The effects of Earth's tilt are not the focus at this level. Direct and indirect sunlight, the reason hours of daylight change throughout the year and the role of Earth's tilt in changing seasons are reserved for grade 7. Shadows change throughout the day due to the apparent movement of the sun. This content can be linked with content from 5.PS.2. As Earth orbits the sun, different stars and constellations are visible during different portions of the year. Stars located in the same direction as the sun are not visible because the sun is so bright compared to the other stars. Stars located in the direction opposite from the sun are seen during nighttime hours. As Earth moves in its orbit around the sun, various sections of the sky are visible during nighttime hours. This allows different stars to be seen at different times of the year. Models, interactive websites and investigations are used to illustrate the predictable patterns and cycles that lead to the understanding of rotation (day and night) and revolution (years).

PHYSICAL SCIENCE (PS)	
Topic: Light, Sound, Forces and Motion This topic focuses on the forces that affect motion. This includes the relationship between the change in speed of an object, the amount of force applied and the mass of the object. Light and sound are explored as forms of energy that move in predictable ways, depending on the matter through which they move.	
Content Statement	**Content Elaboration**
5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted. Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t). Any change in speed or direction of an object requires a force and is affected by the mass of the object and the amount of force applied. Note: Differentiating between mass and weight is not necessary at this grade level.	The motion of an object can change by speeding up, slowing down or changing direction. Forces cause changes in motion. If a force is applied in the direction of an object's motion, the speed will increase. If a force is applied in the direction opposite an object's motion, the speed will decrease. The greater the force acting on an object, the greater the change in motion. The greater the mass of an object, the less influence a force will have on its motion. If no force acts on an object (or the forces are balanced), the object does not change its motion and moves at constant speed in a given direction. If an object is not moving and no force acts on it (or the forces are balanced), the object will remain at rest. A force is described by its strength and the direction that it pushes or pulls an object. More than one force can act on an object at a time. At this grade level, only consider two forces acting on an object either horizontally or vertically. When two forces act on an object, their combined effect influences the motion of that object. The effect forces have on an object depends not only on the forces' strengths, but also on their directions. If the forces have equal strengths, but act in opposite directions, the object's motion will not change, and the forces are considered balanced. A stationary object subject to balanced forces will remain stationary. A moving object subject to balanced forces will continue moving in the same direction at the same speed. Unbalanced forces will cause change in the motion of an object. A stationary object subject to unbalanced forces will move in the direction of the larger force. Inquiry activities should be used to develop student understanding of the effects of forces on the motion of objects.Movement is a change in position. Speed is a measurement of how fast or slow this change takes place. In the same amount of time, a faster object moves a greater distance than a slower object. Speed is calculated by dividing distance traveled by elapsed time. An object that moves with constant speed travels the same distance in each successive unit of time. When an object is speeding up, the distance it travels increases with each successive unit of time. Speed should be investigated through testing and experimentation. When possible, real-world settings are recommended for the investigations. Virtual investigations, simulations and freeze-frame video also can be used to explore

	concepts of speed. Note 2: While concepts are related to Newton's first and second laws, they should remain conceptual at this grade. Knowing the names of the laws is not required. Memorizing and reciting words to describe Newton's second law is not appropriate. Note 3: Although mathematics is applied to the concept of speed at this grade level, its use should support deeper understanding of the concept and not be taught as the primary definition of speed.
5.PS.2: Light and sound are forms of energy that behave in predictable ways. Light travels and maintains its direction until it interacts with an object or moves from one medium to another and then it can be reflected, refracted or absorbed. Sound is produced by vibrating objects and requires a medium through which to travel. The rate of vibration is related to the pitch of the sound. Note: At this grade level, the discussion of light and sound should be based on observable behavior. Waves are introduced at the middle school level.	Light can travel through some materials, such as glass or water. Light can also travel through empty space, like from the sun to Earth. When light travels from one location to another, it goes in a straight line until it interacts with another object or material. When light strikes objects through which it cannot pass, shadows are formed. As light reaches a new material, it can be absorbed, refracted, reflected or can continue to travel through the new material; one of these interactions may occur or many may occur simultaneously, depending on the material. Light can be absorbed by objects, causing them to warm. How much an object's temperature increases depends on the material of the object, the intensity of and the angle at which the light strikes its surface, how long the light shines on the object and how much light is absorbed. Investigating and experimenting with temperature changes caused by light striking different surfaces can be virtual or in a lab setting. When light passes from one material to another, it is often refracted at the boundary between the two materials and travels in a new direction through the new material (medium). For example, a magnifying lens bends light and focuses it toward a single point. A prism bends white light and separates the different colors of light. Prisms and magnifying lenses can be used to observe the refraction of light. Visible light can be emitted from an object (like the sun) or reflected by an object (like a mirror or the moon). The reflected colors are the only colors visible when looking at an object. For example, a red apple looks red because the red light that hits the apple is reflected while the other colors are absorbed. The additive rules for color mixing of light, other than the fact that white light is a mixture of many colors, are reserved for later grades. The wave nature of sound and light are not introduced at this level nor are parts of the electromagnetic spectrum other than visible light. Pitch can be altered by changing how fast an object vibrates. Objects that vibrate slowly produce low pitches; objects that vibrate quickly produce high pitches. Audible sound can only be detected within a certain range of pitches. Sound must travel through a material (medium) to move from one place to another. This medium may be a solid, liquid or gas. Sound travels at different speeds through different media. At this grade, how sound travels through the medium is not appropriate as atoms and molecules are not introduced until grade 6. Once sound is produced, it travels outward in all directions until it reaches a different medium. When it

	encounters this new medium, the sound can continue traveling through the new medium, become absorbed by the new medium, bounce back into the original medium (reflect) or engage in some combination of these possibilities. Light travels faster than sound. Technology, virtual simulations and models can help demonstrate the movement of light and sound. Experimentation, testing and investigation (3-D or virtual) are essential components of learning about light and sound properties.

LIFE SCIENCE (LS)	
Topic: Interactions within Ecosystems This topic focuses on foundational knowledge of the structures and functions of ecosystems.	
Content Statement	**Content Elaboration**
5.LS.1: Organisms perform a variety of roles in an ecosystem. Populations of organisms can be categorized by how they acquire energy. Food webs can be used to identify the relationships among producers, consumers and decomposers in an ecosystem.	The content statements for fifth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's foundational theories: dynamic relationships within ecosystems. It is recommended that the content statements be combined and taught as a whole. For example, it is important that the ecological role of organisms is interwoven with a clear understanding that all living things require energy. Plants and some microorganisms are producers. They are the foundation of the food web. Producers transform energy from the sun and make food through a process called photosynthesis. Animals get their energy by eating plants and other animals that eat plants. Animals are consumers and many form predator-prey relationships. Decomposers (primarily bacteria and fungi) are consumers that use waste materials and dead organisms for food. Decomposers also return nutrients to the ecosystem. One way that ecosystem populations interact is centered on relationships for obtaining energy. Food webs are defined in many ways, including as a scheme of feeding relationships, which resembles a web. This web serves as a model for feeding relationships of member species within a biological community. Members of a species may occupy different positions during their lives. Food chains and webs are schematic representations of real-world interactions. For this grade level, it is enough to recognize that food webs represent an intertwining of food chains within the same biological community. Organisms have symbiotic relationships in which individuals of one species are dependent upon individuals of another species for survival. Symbiotic relationships can be categorized as mutualism (where both species benefit), commensalism (where

	one species benefits and the other is unaffected), and parasitism (where one species benefits and the other is harmed). Investigations of locally threatened or endangered species can be conducted and include considerations of the effects of remediation programs, species loss and the introduction of new species on the local ecosystem. Note: At this grade, species can be defined by using Ernst Mayer's definition "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups."
5.LS.2: All of the processes that take place within organisms require energy. For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred and transformed by producers into energy that organisms use through the process of photosynthesis. That energy is used or stored by the producer and can be passed from organism to organism as illustrated in food webs.	The content statements for fifth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's foundational theories: dynamic relationships within ecosystems. It is recommended that the content statements be combined and taught as a whole. For example, it is important that the ecological role of organisms is interwoven with a clear understanding that all living things require energy. Virtual simulations and investigations can help demonstrate energy flow through the trophic levels. Energy flows through an ecosystem in one direction, from the sun to photosynthetic organisms to consumers (herbivores, omnivores, carnivores) and decomposers. The exchange of energy that occurs in an ecosystem can be represented as a food web. The exchange of energy in an ecosystem is essential because all processes of life for all organisms require a continual supply of energy. Direct and remote sensing (e.g., satellite imaging and other digital-research formats) can be used to help visualize what happens in an ecosystem when new producers, including invasive species, enter an ecosystem. The information gained should be used to determine the relationship between the producers and consumers within an ecosystem.