In Unit 3, students began to explore human impact on natural systems through their Culminating Project, as they thought about why algal blooms have become more common in recent years. In this unit, students continue with this theme, specifically looking at why global temperatures are on the rise and what this means for organisms around the world. In this culminating project, students are asked to design a method to monitor and minimize this type of human impact on a particular organism.

The integrated model requires students to access and use a wide range of ideas from prior grades. This content knowledge spans five different Disciplinary Core Ideas in this unit: ESS3.D: Global Climate Change, ETS1.A: Defining and Delimiting Engineering Problems, LS1.B: Growth and Development of Organisms, ESS3.C: Human Impacts on Earth Systems, and ETS1.B: Developing Possible Solutions.

As students explore these core ideas, they build on their skills in the following science and engineering practices: Asking Questions and Defining Problems, Designing Solutions, and Engaging in Argument From Evidence. In addition to science and engineering practices, students also continue to build on their knowledge of the crosscutting concepts of Cause and Effect and Stability and Change.

\*This summary is based on information found in the NGSS Framework.

**K-8 Progression of Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts for Unit 4**

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| **Disciplinary Core Ideas** | **K-2** | **3-5** | **6-8** |
| **ESS3.D**  **Global Climate Change** | N/A | N/A | Human activities affect global warming. Decisions to reduce the impact of global warming depend on understanding climate science, engineering capabilities, and social dynamics. |
| **ETS1.A**  **Defining and Delimiting Engineering Problems** | A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. Asking questions, making observations, and gathering information are helpful in thinking about problems. Before beginning to design a solution, it is important to clearly understand the problem. | Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. | The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. |
| **LS1.B**  **Growth and Development of Organisms** | Parents and offspring often engage in behaviors that help the offspring survive. | Reproduction is essential to every kind of organism. Organisms have unique and diverse life cycles. | Animals engage in behaviors and plants have specialized structures that increase the odds of reproduction. An organism’s growth is affected by both genetic and environmental factors. |
| **ESS3.C**  **Human Impact on Earth Systems** | Things people do can affect the environment, but they can make choices to reduce their impacts. | Societal activities have had major effects on land, ocean, atmosphere, and even outer space. Societal activities can also help protect Earth’s resources and environments. | Human activities have altered the biosphere sometimes damaging it, although changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people’s impacts on Earth. |
| **ETS1.B**  **Developing Possible Solutions** | Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem’s solutions to other people. | Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. | There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. |

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| **Science and Engineering Practices** | **K-2** | **3-5** | **6-8** |
| **Asking Questions and Defining Problems\*** | Asking questions and defining problems in K-2 builds on prior experiences and progresses to simple descriptive questions that can be tested.   * Ask questions based on observations to find more information about the natural and/or designed world(s). * Define a simple problem that can be solved through the development of a new or improved object or tool. | Asking questions and defining problems in 3-5 builds on prior experiences and progresses to specifying qualitative relationships.   * Ask questions about what would happen if a variable is changed. * Use prior knowledge to describe problems that can be solved. * Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. | Asking questions and defining problems in 6-8 builds on prior experiences and progresses to specifying relationships between variables, and clarifying arguments and models.   * Ask questions to identify and clarify evidence of an argument. * Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. |
| **Designing Solutions\*** | Designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in designing solutions.   * Use tools and/or materials to design and/or build a device that solves a specific problem. * Generate and/or compare multiple solutions to a problem. | Designing solutions in 3-5 builds on prior experiences and progresses to the use of evidence in designing multiple solutions to design problems.   * Apply scientific ideas to solve design problems. * Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. | Designing solutions in 6-8 builds on prior experiences and progresses to include designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.   * Apply scientific ideas or principles to design an object, tool, process or system. |
| **Engaging in Argument from Evidence\*** | Engaging in argument from evidence in K-2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).   * Construct an argument with evidence to support a claim. * Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence. | Engaging in argument from evidence in 3-5 builds on prior experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).   * Construct and/or support an argument with evidence, data, and/or a model. * Use data to evaluate claims about cause and effect. * Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. | Engaging in argument from evidence in 6-8 builds on prior experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).   * Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. * Evaluate competing design solutions based on jointly developed and agreed-upon criteria. |

\*These SEPs are summatively assessed using the Culminating Project or a Task-Specific Rubric.

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| **Crosscutting Concepts** | **K-2** | **3-5** | **6-8** |
| **Cause and Effect\*** | Students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their own ideas about causes.   * Events have causes that generate observable patterns. | Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship.   * Cause and effect relationships are routinely identified, tested, and used to explain change. * Events that occur together with regularity might or might not be a cause and effect relationship. | Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.   * Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. * Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. |
| **Stability and Change** | Students observe some things stay the same while other things change, and things may change slowly or rapidly.   * Some things stay the same while other things change. * Things may change slowly or rapidly. | Students measure change in terms of differences over time, and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change.   * Some systems appear stable, but over long periods of time will eventually change. | Students explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale. Students learn changes in one part of a system might cause large changes in another part, systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time.   * Stability might be disturbed either by sudden events or gradual changes that accumulate over time. |

\*These CCCs are summatively assessed using the Culminating Project or a Task-Specific Rubric.

**Progression of Knowledge from Kindergarten – 8th grade**

ESS3.D. Global Climate Change: This DCI is not introduced until the middle school PE addressed in this unit. However, in earlier grades, students do engage with various aspects of natural resource use and human impact that offer connections to this DCI. For example, in 4th grade, students learn about how energy is derived from natural resources and their use affects the environment. Then in 5th grade, students begin to think about general human impacts on Earth’s environments and what they can to protect these environments. In this unit, students focus in one specific environmental impact—how human activities are contributing to the rise in global temperatures.

The following is the progression of the Performance Expectations for this DCI:

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| **MS-ESS3-5** | Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. |

ETS1.A. Defining and Delimiting Engineering Problems: In Kindergarten through second grade, students first begin to approach situations as problems to be solved through engineering. They learn to ask questions and gather information to clearly understand a problem. In third through fifth grade, students build on an understanding of the problem to also identify criteria and constraints surrounding the problem. In this sixth grade unit, students take this process a step further by defining criteria and constraints more precisely, including consideration of scientific principles and other relevant knowledge. In Kindergarten to second grade, students focus on the science and engineering practice of Asking Questions in order to help them with the practice of Defining Problems, which continues to be the main focus in subsequent grades.

The following is the progression of the Performance Expectations for this DCI:

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| **K-2-ETS1-1** | Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. |
| **3-5-ETS1-1** | Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. |
| **MS-ETS1-1** | Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. |

LS1.B. Growth and Development of Organisms: In first grade, students begin to engage with this DCI by thinking about plant and animal behaviors that help the offspring to survive. In third through fifth grade, students take a step back from survival behaviors and look at the big picture of organisms—that while diverse, they all have a life cycle that involves reproduction. In Unit 3, students focused on the growth aspect of the life cycle as they gathered evidence for how environmental and genetic factors influence the growth of plants. In this unit, students build on their prior knowledge from first grade as they learn that certain animal behaviors and plant structures can increase the odds of reproduction—which is another key aspect of the life cycles that they explored in third grade. Students first focus on the crosscutting concept of Patterns, but later switch to the lens of Cause and Effect. There is also a wide variety of Science and Engineering Practices across the PEs, as shown below.

The following is the progression of the Performance Expectations for this DCI:

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| **1-LS1-2** | Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. |
| **3-LS1-1** | Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. |
| **MS-LS1-4** | Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect probability of successful reproduction of animals and plants respectively. |
| **MS-LS1-5** | Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. |

ESS3.C. Human Impacts on Earth Systems: In Kindergarten through second grade, students begin to think about how the things that people do to live comfortably can affect the world around them. In turn, they also consider how they might make choices to reduce this impact. In third-fifth grade, students continue an exploration of problematic human impacts and the corresponding solutions communities are already putting in place. This sets the stage for this unit, as students dig into a specific human impact to design their own method for monitoring and minimizing that human impact. In a later middle school unit, students will envision the bigger picture by examining how increases in human population and per-capita consumption cause a greater negative impact on Earth’s systems. Aside from this unit, students fluctuate mostly between the SEPs of Engaging in Argument From Evidence and Obtaining, Evaluating, and Communicating Information. Throughout all the Performance Expectations below, students are engaging with the CCCs of Cause and Effect or Systems and System Models.

The following is the progression of the Performance Expectations for this DCI:

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| **K-ESS2-2** | Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. |
| **K-ESS3-3** | Communicate solutions that will reduce the impact of humans on the land, water, air, and/or living things in the local environment. |
| **5-ESS3-1** | Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment. |
| **MS- ESS3-3** | Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. |
| **MS-ESS3-4** | Construct an argument supported by evidence for how increases in human population and per-capital consumption of natural resources impact Earth’s systems. |

ETS1.B. Developing Possible Solutions: In Kindergarten through second grade, students begin communicating multiple designs in the form of diagrams and sketches. By third to fifth grade, students move from mere drawings to actually testing out their designs to see how they perform under different conditions. Students then use this data to make improvements. As in Kindergarten through second grade, students practice the idea that communication of designs with peers is an essential part of the design process. In Unit 2, students moved towards using data from testing solutions to inform improvements, focusing on the idea that parts of different solutions can be used to make an even better solution. In this unit, students focus on another PE associated with this DCI, which asks students to use systematic processes to evaluate solutions for how well they meet criteria and constraints. At the different grade levels, students engage in a variety of different science and engineering practices: Developing Models in K-2, Designing Solutions (specifically comparing solutions) in 3-5, and Analyzing and Interpreting Data and Engaging in Argument From Evidence in 6-8. This is representative of the different practices students are engaging with, described above.

The following is the progression of the Performance Expectations for this DCI:

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| **K-2-ETS1-2** | Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem. |
| **3-5-ETS1-2** | Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. |
| **MS-ETS1-2** | Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. |
| **MS-ETS1-3** | Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. |