THE BENEFITS OF ADVANCING THE NEXT GENERATION SCIENCE STANDARDS IN THE ELEMENTARY GRADES

by

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What are the benefits of advancing the Next Generation Science Standards (NGSS) standards in the elementary grades? This project will show the benefits and outcomes of modifying the proposed curriculum map to accommodate a fifth grade year in which no new curriculum would be taught. This year without new benchmark standards could be an available time for independent learning, remediation of prerequisite science skills and vocabulary or perhaps a capstone-like year of inquiry for the students transitioning into secondary settings. This shift was put into a structured map. Maps showing the difference between the planned course of instruction in science in the state of Minnesota as well as the amended curriculum map were included. The amended map was provided for those interested in implementation. Once the amended map was laid out for implementation, even if only in theory, this chapter also detailed potential uses for the space created by advancing the NGSS standards in the elementary grades. This project showed those potential benefits while laying the groundwork for implementation of NGSS standards as a viable curricular model.

For the framework of this project, I used the 2019 proposed curriculum map for the State of Minnesota, scheduled for district implementation by the 2024 school year. The Minnesota Department of Education also required an inclusion of cross-cultural learning, framed around the curriculum. Because of these modifications on behalf of the state, these standards once rolled out, will not be a NGSS certified curriculum map, rather Minnesota's map will be considered NGSS-aligned.

The result in shifting curriculum will be a fifth grade year without new standards to be taught. This gap year will be used as a cornerstone for the support of fostering the continuation of scientific learning in a student's secondary school career for younger learners, as well as opportunities for remediation if necessary and project-based inquiry for the student transitioning to a secondary school setting. The body of this project included the requirements to restructure a curriculum map, excluding the fifth grade from consideration. This would then allow individual districts or educational institutions to incorporate other instructional and translational science based curriculum

for the fifth grade learner. This change in the existing map could serve not only as an aid in the student's shift from an elementary school setting into that of a middle or secondary setting, but this scaffolded transition could allow them to continue with phenomena-based curriculum in an inquiry or independent learning setting.

I focused my attention on constructing this project with a public school district as the audience, using Minnesota's perspective 2019 Kindergarten through fifth grade science standard curriculum map as the sample. After the adjustments were made to the curriculum map, I was able to theorize what a fifth grade classroom would look like and what they could do with this new found space. It is not the intent of this project or capstone to simply abandon science or fill what would otherwise be an available space in a school day with other subjects or curriculum work. The first theoretical step would be the inclusion of a student survey, a sample of which is included in the project. At the point of allowing students to investigate their passions and interests, classroom teachers should consider scheduling a consistent time in their weekly schedule dedicated to science throughout the school year. This consistency would provide a stable scaffold for the learner to be held accountable for timely project completion, teacher/student check-ins, and available time for those wishing for small-group projects, whether they be guided or unguided. Small group instruction can cover enrichment of previously covered standards, tailored to teacher and student preferences. In addition, units not specifically covered by standards, but addressed in content areas could be engaged in. For example, a lesson on Newtonian physics using model rockets. The website for Estes Model Rocket company has downloadable lesson plans available on their website, that are free of charge for educators and multifaceted in their design. They cover the principles of physics, the Engineering Design Process as well as the cross-curricular historical contexts and real-life applications. Perhaps a study of the landforms in the vicinity of the school or community or a year-long environmental study of the community at-large and the human footprint left by said community? These are just a few topics ideas that could be investigated as a part of a student-centered, student-directed year of

scientific learning in which the students drove the questioning and the educator acted as a facilitator. In short, if you were a fifth grade teacher, when it came to science, knowing that the state standards have been taught. What would you teach and how would you teach it?

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Estes Education Lesson Plans. (n.d.). Retrieved July 30, 2021 from the website https://estesrockets.com/edu/lesson-plans/#plans2

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Capstone Project: The Benefits of Advancing the Next Generation Science Standards (NGSS) in the Primary Grades

A project artifact of Matt Millslagle, candidate for Masters of Art in Teaching

This project will serve to demonstrate the benefits of changing curriculum map of the current Commissioner-approved draft of the 2019, NGSS-aligned, science standards from the state of Minnesota. These changes will demonstrate an ability to create an opportunity for schools to teach all the aligned standards while providing an opening in the science curriculum within the fifth grade year, free from required state standards in science. It's in this open year that schools can potentially address science skill remediation, small-group and/or teacher-guided study for enrichment, standardized test prep, or other independent study projects. The use of student surveys could be implemented to gauge interest and assist teachers in assigning appropriate projects and curriculum for students during this year. The core inspiration behind these state changes was to embrace the Next Generation Science Standards (NGSS). These standards were designed to engage science-minded learners at a young age and keep them engaged throughout their public school career. The potential outcomes of the implementation of this project will aid in solidifying those goals of activating, engaging and encouraging life-long scientific learners.

Project

- Curriculum map from the Minnesota Department of Education, in its current form (fig. 1)
- Modified curriculum map, reconfigured to implement all standards by the end of of the fourth grade (fig. 2)
- Recommendations and templates for the accommodated space in the curriculum map during the fifth grade.

Recommendations and templates

Should a district choose to implement a curricular shift such as this, a beneficial place to start would be with a student survey. A survey would be used to gauge student interest in both project style and content area for an independent study project or small-group instruction. A sample survey would look like this: Student interest survey link

At the point of allowing students to investigate their passions and interests, classroom teachers should consider scheduling a consistent time in their weekly schedule, dedicated to science throughout the school year. This consistency would provide a stable scaffold for the learner to be held accountable for timely project completion, teacher/student check-ins, and available time for those wishing for small-group projects, whether they be guided or unguided. Small group instruction can cover enrichment of previously covered standards, tailored to teacher and student preferences. In addition, units not specifically covered by standards, but addressed in content areas could be engaged in. For example, a lesson on Newtonian physics using model rockets. The website for Estes Model Rocket company has free, downloadable lesson plans (Rocketry Lesson Plans) that are multifaceted in their design. They cover the principles of physics, the Engineering Design Process as well as the cross-curricular historical contexts and real-life applications. Perhaps a study of the landforms in the vicinity of the school or community or a year-long environmental study of the community at-large and the human footprint left by said community? These are just a few topics ideas that could be investigated as a part of a student-centered, student-directed year of scientific learning in which the students drove the questioning and the educator acted as a facilitator. In short, if you were a fifth grade teacher, when it came to science, knowing that the state standards have been taught. What would you teach and how would you teach it?

Figure 1: Current MN Dept. of Education (draft) curriculum map for grades K through 5.

Grade	Strand	Substrand	Standard	Content Area	Benchmark
K	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Earth and Space Science	0E.1.1.1.1 Ask questions to obtain information from weather forecasts to prepare for and respond to severe weather.* (P: 1, CC: 7, CI: ESS3, ETS2) *Emphasis is on local forms of severe weather that may arise quickly and should include examples of engineered solutions to severe weather (such as clothing to wear or places to safely shelter).*
K	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Earth and Space Science	0E.1.1.1.2 Ask questions about how a person may reduce the amount of natural resources the individual uses.* (P: 1, CC: 2, CI: ESS3) *Examples of questions may include reusing paper to reduce the number of trees cut down and recycling cans and bottles to reduce the amount of plastic, glass, or metal used.*
K	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	0P.1.2.1.1 Collect and organize observational data to determine the effect of sunlight on Earth's surface. (P: 3, CC: 2, CI: PS3, ETS2) *Examples of Earth's surface may include sand, soil, rocks, and water. Data may be organized in pictographs or bar graphs. Examples of observations may include heating, growth of plants melting of snow, and shadows.*
K	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Life Science	0L.1.2.1.2 Make observations of plants and animals to compare the diversity of life in different habitats. (P: 3, CC: 1, CI: LS4) *Emphasis is on the diversity of living things in a variety of different habitats and patterns across those habitats.*
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Physical Science	Ph 0P.2.1.1.1 Sort objects in terms of natural/human-made, color, size, shape, and texture, then communicate the reasoning for the sorting system. (P: 4, CC: 2, CI: PS1) *Emphasis is on using observations to describe patterns and/or relationships in the natural and designed world in order to answer scientific questions and solve problems.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	0E.2.1.1.2 Make daily and seasonal observations of local weather conditions to describe patterns over time.** (P: 4, CC: 1, CI: ESS2) *Examples of qualitative observations may include descriptions of the weather (such as sunny, cloudy, rainy, and warm). Examples of quantitative observations may include numbers of sunny, windy, and rainy days in a month. Examples of patterns may include that it is usually cooler in the morning than in the afternoon and that different months have different numbers of sunny days versus cloudy days in different months.*
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Life Science	0L.2.1.1.3 Record and use observations to describe patterns of what plants and animals (including humans) need to survive.** (P: 4, CC: 1, CI: LS1) *Examples of patterns may include that animals need to take in food, but plants do not; different animals need different kinds of food; plants require light; and that all living things need water.*
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Physical Science	0P.2.2.1.1 Identify and describe patterns that emerge from the effects of different strengths or different directions of pushes and pulls on the motion of an object.** (P: 5, CC: 2, CI: PS2) *Emphasis is on different relative strengths or different directions, but not both at the same time. Examples of pushes or pulls may include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.*
K	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Life Science	0L.3.1.1.1 Develop a simple model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. (P: 2, CC: 4, CI: LS2) *Examples of relationships may include that deer eat buds and leaves, therefore, they usually live in forested areas; and grasses need sunlight, so they often grow in meadows. Examples of models may include food chains, collages, and/or sorting activities.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
K	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Physical Science	0P.3.2.2.1 Design and build a structure to reduce the warming effect of sunlight on Earth's surface.* (P: 6, CC: 2, CI: PS3, ETS1) *Emphasis of the practice is on choosing appropriate materials and tools to solve a problem. Emphasis of the core idea is on understanding the heating effects of sunlight. Examples of structures may include umbrellas, canopies and tents.*
K	4 Communicate reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Physical Science	0P.4.1.1.1 Construct an argument supported by evidence for whether a design solution works as intended to change the speed or direction of an object with a push or a pull.* (P: 7, CC: 2, CI: PS2, ETS1) *Examples of problems requiring a solution may include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions may include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.*
K	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Physical Science	0P.4.2.2.1 Communicate design ideas for a structure that reduces the warming effect of sunlight on Earth's surface.* (P: 8, CC: 2, CI: PS3, ETS1) *Examples of written designs include models, drawings, writing, or numbers.*
1	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Life Science	1L.1.1.1.1 Ask questions based on observations about the similarities and differences between young plants and animals and their parents. (P: 1, CC: 2, CI: LS3) *Examples of observations may include leaves from the same kind of plant are the same shape but can differ in size; and a particular breed of dog looks like its parents but is not exactly the same.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
1	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	1P.1.2.1.1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. (P: 3, CC: 2, CI: PS4) *Examples of vibrating materials that make sound may include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate may include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.*

1	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Physical Science	1P.2.1.1.1 Identify and describe patterns obtained from testing different materials and determine which materials have the properties that are best suited for producing and/or transmitting sound.* (P: 4, CC: 1, CI: PS1, ETS1) *Examples of materials may be wood, paper, string, plastics, cloth, etc.*
1	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	1E.2.2.1.1 Use quantitative data to identify and describe patterns in the amount of time it takes for Earth processes to occur and determine whether they occur quickly or slowly. (P:5, CC: 7, CI: ESS1) *Emphasis of the core idea is that some Earth processes happen quickly (like tornadoes and thunderstorms) and some slowly (like the erosion of soil). Examples of data may include firsthand observations data from books, videos, pictures, or historical photos.*
1	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Life Science	1L.3.1.1.1 Develop a simple model based on evidence to represent how plants or animals use their external parts to help them survive, grow, and meet their needs. (P: 2, CC: 6, CI: LS1) *Examples of external parts may include acorn shells, plant roots, thorns on branches, turtle shells, animal scales, animal tails, and animal quills.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
1	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Physical Science	1P.3.2.2.1 Design and build a device that uses light or sound to solve the problem of communicating over a distance.* (P: 6, CC: 6, CI: PS4, ETS1, ETS2) *Examples of devices may include paper cup and string "telephones" and a pattern of drum beats.*

1	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Life Science	1L.3.2.2.2 Plan and design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* (P: 6, CC: 6, CI: LS1, ETS2) *Examples of human problems that can be solved by mimicking plant or animal solutions may include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills, and detecting intruders by mimicking eyes and ears.*
1	4 Communicate reasons, arguments and idea to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Earth and Space Science	1E.4.1.1.1 Construct an argument based on observational evidence for how plants and animals (including humans) can change the non-living aspects of the environment to meet their needs. (P: 7, CC: 4, CI: ESS2) *Examples of plants and animals changing their environment may include a squirrel digging in the ground to hide its food and tree roots breaking concrete.*
1	4 Communicate reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.2 Students will be able to argue from evidence to justify the best solution to a problem or to compare and evaluate competing designs, ideas, or methods.*	Earth and Space Science	1E.4.1.2.1 Construct an argument with evidence to evaluate multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* (P: 7, CC: 7, CI: ESS2, ETS2) *Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water; and different designs for using shrubs, grass, and trees to hold back the land.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
1	4 Communicate reasons, Arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	1E.4.2.1.1 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* (P: 8, CC: 4, CI: ESS3) *Examples of human actions that impact the land may include cutting trees to produce paper, using resources to produce bottles, and using water for bathing and brushing teeth. Examples of solutions may include reusing paper and recycling cans and bottles.*
1	4 Communicate reasons, arguments and ideas to others.	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Life Science	1L.4.2.1.2 Obtain information using various features of texts and other media to determine patterns in the behavior of parents and offspring that help offspring survive. (P: 8, CC: 1, CI: LS1) *Examples of text features include headings, glossaries, electronic menus, pictures, illustrations, icons, etc. Examples of behavior patterns may include the signals that offspring make (such as crying, chirping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).*

1	4 Communicate reasons, arguments and ideas to others.	4.2 Obtaining, evaluating and communicating information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Physical Science	1P.4.2.2.1 Communicate solutions that use materials to provide shelter, food, or warmth needs for communities including Minnesota American Indian tribes and communities.* (P: 8, CC: 2, CI: PS1, ETS2) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples of solutions may include past and current building practices that incorporate natural building materials and other green practices as used in sweat lodges, green roofs, moss used for insulation, or sustainable food production and tools used for ricing (harvesting and finishing).*
2	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	2P.1.1.1.1 Ask questions about an object's motion based on observation, that can be answered by an investigation. (P: 1, CC: 1, CI: PS2) *Examples of questions may include what is causing the motion, what type of motion (circular, bouncing, etc.) and what changes are happening in the motion.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
2	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	2P.1.2.1.1 Plan and conduct an investigation to describe how heating and cooling affects different kinds of materials based upon their observable properties. (P: 3, CC: 1, CI: PS1) *Examples of materials may include metals, cloth, plastics, styrofoam, wood and glass.*
2	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	2E.2.1.1.1 Represent data to describe typical weather conditions expected during a particular season. (P: 4, CC: 1, CI: ESS2) *Examples of data may include temperature, precipitation, and wind direction. Data displays can include pictographs and bar graphs.*
2	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	2E.2.1.1.2 Analyze data from tests of objects designed to reduce the impacts of a weather-related hazards and compare the strengths and weaknesses of how each performs.* (P: 4, CC: 2, CI: ESS3, ETS1) *Emphasis is on data from tests of student designed objects. Examples of design solutions to weather related hazards may include barriers to prevent flooding or snow drifting, structures for sun shading, materials for clothing, and orientation of bus shelters.*

2	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Physical Science	2P.2.2.1.1 Identify and predict quantitative patterns of the effects of balanced and unbalanced forces on the motion of an object.** (P: 5, CC: F412, CI: PS2) *Examples may include an unbalanced force on one side of a ball can make it start moving; and balanced forces pushing on a box from both sides will not produce any motion at all. Data displays may include pictographs and bar graphs.*
2	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Physical Science	2P.3.1.1.1 Develop a simple diagram or physical model To illustrate how some changes caused by heating or cooling can be reversed and some cannot.** (P: 2, CC: 2, CI: PS3) *Examples of reversible changes may include materials such as water and butter at different temperatures. Examples of irreversible changes may lude cooking an egg, freezing a plant leaf, and heating paper. Examples of diagrams may include a flow chart.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
2	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Life Science	2L.3.2.2.1 Engineer a device that mimics the structures and functions of plants or animals in seed dispersal.* (P: 6, CC: 6, CI: LS2, ETS1) *Emphasis is on how specific structures have particular functions. Examples of seed dispersal by animals may include feeding and subsequent elimination of seeds, or attachment of seeds/pollen to animal structures. Examples of seed dispersal by plants may include various wind-catching designs (as in dandelions or maple trees) or colors and smells that attract pollinators.*
2	4 Communicate reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Life Science	2L.4.1.1.1 Construct an argument with evidence that evaluates how in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (P: 7, CC: 2, CI: LS4, ETS2) *Emphasis is on the interdependence of parts of a system (organisms and their habitat). Examples of habitats should include those found in Minnesota, such as a wetland, prairie, or garden. Examples of evidence may include needs and characteristics of the organisms and habitats involved.*
2	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	2E.4.2.1.1 Obtain and use information from multiple sources to identify where water is found on Earth. (P: 8, CC: 1, CI: ESS2) *Emphasis of the practice is on learning how to use texts and maps to integrate and evaluate content. Examples may include liquid water in oceans, lakes, rivers, and ponds; and solid water in glaciers and polar ice caps.*

2	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	2E.4.2.1.2 Obtain and use information from multiple sources, including electronic sources, to describe climates in different regions of the world.** (P: 8, CC: 1, CI: ESS2) *Emphasis of the practice is on learning how to use electronic sources to integrate and evaluate content. Examples of information may include data on an area's typical weather conditions and how these patterns are considered climate.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
2	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Physical Science	2P.4.2.2.1 Obtain information and communicate how Minnesota American Indian Tribes and communities and other cultures apply knowledge of the natural world in determining which materials have the properties that are best suited for an intended purpose.* (P: 8, CC: 2, CI: PS1, ETS1) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota . Emphasis of the practice is on obtaining, interpreting, and communicating information related to how various cultures have built materials suited for intended purposes according to their properties. Examples of materials may include instruments (Cedar for knockers and Black Spruce for poles) for ricing, birch bark for baskets or other containers for carrying water, and sinew for connecting parts of tools.*
3	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problem	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	l.1.1.1 Ask questions based on observations about why objects in darkness can be seen only when illuminated. (P: 1, CC: 2, CI: PS4) *Emphasis should be on addressing the misconception that people can see in the dark if they wait long enough and on the way eyes receive light. Examples of observations may include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight.*
3	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	3P.1.2.1 1 Plan and conduct a controlled investigation to determine the effect of placing objects made with different materials in the path of a beam of light. (P: 3, CC: 2, CI: PS4) *Emphasis is on conducting fair tests by controlling variables. Examples of materials may include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
3	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Life Science	3L.1.2.1.2 Plan and conduct an investigation to determine how amounts of sunlight and water impact the growth of a plant. (P: 3, CC:2, CI: LS2) *Emphasis of the practice is on conducting fair tests and using data to support explanations. Examples of investigations may include simple experiments with fast growing plants.*
3	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	3E.2.1.1.1 Record observations of the sun, moon, and stars and use them to describe patterns that can be predicted.** (P: 4, CC: 1, CI: ESS1) *Examples of patterns may include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.*
3	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	3E.2.2.1.1 Organize and electronically present collected data to identify and describe patterns in the amount of daylight in the different times of the year.** (P: 5, CC: 1, CI: ESS1) *Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.*
3	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Physical Science	3P.3.1.1.1 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. (P: 2, CC: 2, CI: PS4) *Examples of models may include diagrams, drawings, physical models, or computer programs.*
3	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Life Science	3L.3.1.1.2 Develop multiple models to describe how organisms have unique and diverse life cycles but all have birth, growth, reproduction, and death in common. (P: 2, CC: 4, CI: LS1) *Emphasis is on the pattern of changes organisms go through during their life. Examples of models may include diagrams, drawings, physical models, or computer programs.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark

3	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.1 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others.	Life Science	3L.3.2.1.1 Construct an explanation using evidence from various sources for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. (P: 6, CC: 2. CI: LS4) *Examples of cause and effect relationships may include how individual plants of the same species with different length thorns may be more or less likely to be eaten by predators; or animals that have better camouflage coloration than others of their species may be more likely to survive and therefore more likely to leave offspring.*
3	4 Communicate reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Life Science	3L.4.1.1.1 Construct an argument about strategies animals use to survive. (P: 7, CC: 2, CI: LS2) *Emphasis is on group behavior and how being part of a group helps animals obtain food, defend themselves, and cope with changes. Examples of animals should include wolves or other animals that live in Minnesota.*
3	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Life Science	3L.4.2.1.1 Obtain information from various types of media to support an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.** (P: 8, CC: 4, CI: LS1) *Examples of structures may include thorns, stems, roots, colored petals, heart, stomach, lungs, brain, and skin. Examples of media may include electronic sources.*
3	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Earth and Space Science	3E.4.2.2.1 Gather information and communicate how Minnesota American Indian Tribes and communities and other cultures use patterns in stars to make predictions and plans. (P 8, CC: 1, CI: ESS1) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota . Examples may include using star maps to predict seasons, star patterns to inform navigation, and using star stories to identify numeric patterns that guide behavior.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
4	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	4P.1.1.1.1 Ask questions to determine cause and effect nships of electric and magnetic interactions between two objects not in contact with each other. (P: 1, CC: 2, CI: PS2) *Examples of an electric force may include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force may include the force between two permanent magnets, the force between an electromagnet and steel paper clips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships may include how the distance between objects affects the strength of the force and how the orientation of magnets affects the direction of the magnetic force.*

4	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Earth and Space Science	4E.1.1.1.2 Ask questions about how water moves through the Earth system and identify the type of question. (P: 1, CC: 5, CI: ESS2) *Emphasis is on the processes of evaporation, condensation, and precipitation. Examples of types of questions may include those that can be tested by an experiment, and questions that may be answered from a text.*
4	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.2 Students will be able to ask questions about a problem to be solved so they can define constraints and specifications for possible solutions.*	Physical Science	4P.1.1.2.1 Define a simple design problem that can be solved by applying scientific ideas about magnets.* (P:1, CC: 2, CI: PS2, ETS2) *Example may include constructing latch to keep the door shut and creating a device to keep two moving objects from touching each other.*
4	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Earth and Space Science	4E.1.2.1.1 Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.* (P: 3, CC: 2, CI: ESS2) *Emphasis is on predicting the rate of change when variables are changed. Examples of variables to test may include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
4	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Earth and Space Science	4E.1.2.1.2 Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.* (P: 3, CC: 2, CI: ESS2, ETS1; ETS2) *Examples of prototypes to prevent erosion include retaining walls, wind breaks, use of shrubs or other vegetation, and drainage systems.*
4	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	4E.2.2.1.1 Interpret charts, maps and/or graphs of the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** (P: 5, CC: 4, CI: ESS2) *Emphasis is on oceans, lakes, rivers, glaciers, ground water, and polar ice caps.*
4	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Earth and Space Science	4E.3.1.1.1 Develop a model based in part on student observations or data to describe ways the geosphere, biosphere, hydrosphere, and atmosphere interact. (P: 2, CC: 4, CI: ESS2) *Emphasis is on how rock, living things, water, and/or air are individual systems that make up the larger Earth system and interact with each other.*

4	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.1 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others.	Earth and Space Science	4E.3.2.1 1 Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. (P: 6, CC: 1, CI: ESS1) *Examples of evidence from patterns may include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.*
4	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Earth and Space Science	4E.3.2.2.1 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* (P: 6, CC: 2, CI: ESS3, ETS1) *Emphasis is on cause and effect relationships to explain change. Examples of solutions may include designing an earthquake resistant building and improving monitoring of volcanic activity.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
4	4 Communicate reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Life Science	4L.4.1.1.1 Construct or support an argument that traits can be influenced by different environments. (P: 7, CC: 2, CI: LS3) *Emphasis of the practice is on using evidence, data and/or a model to support an argument. Examples of the environment affecting a trait may include the stunted growth of a typically tall plant grown with insufficient water or an animal's weight being influenced by the availability of food.*
4	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	4E.4.2.1.1 Read and comprehend grade appropriate complex texts and/or other reliable media to describe that energy and fuels are derived from natural resources and their uses affect the environment. (P: 8, CC: 2, CI: ESS3, ETS2) *Examples of information about natural resources should include details about those found in Minnesota. Examples of renewable energy resources may include wind, water behind dams, and sunlight; non-renewable energy resources include fossil fuels and fissile materials. Examples of environmental effects may include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution and global warming from burning fossil fuels.*
4	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Life Science	4L.4.2.1.2 Obtain information from various media sources to determine that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.** (P: 8, CC: 1, CI: LS3) *Emphasis of the practice is to compare and/or combine information across texts and other reliable media. Emphasis is on organisms other than humans and the patterns in traits between offspring and their parents or among siblings.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
4	4 Communicate reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicate information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Earth and Space Science	4E.4.2.2.1 Obtain and combine multiple sources of information about ways individual communities, including Minnesota American Indian Tribes and communities and other cultures use evidence and scientific principles to make decisions about the uses of Earth's resources.* (P: 8, CC: 4, CI: ESS3, ETS1) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota . Examples may include balancing the water, soil, wildlife, plant, and human needs to support sustainable use of resources.*
5	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	5P.1.1.1.1 Ask investigatable questions and predict reasonable outcomes about the changes in energy, related to speed, that occurs when objects interact. (P:1, CC: 5, CI: PS3) *Emphasis is on the change in energy due to a change in speed, not on the forces, as objects interact. Example of a question: Where and how do marbles move after a collision?*
5	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	5P.1.2.1.2 Conduct an investigation to determine whether the mixing of two or more substances results in new substances. (P: 3, CC: 2, CI: PS1) *Emphasis is on conducting fair tests by controlling variables.*
5	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	5P.1.2.1.3 Evaluate appropriate methods and tools to identify materials based on their properties prior to investigation. (P: 3, CC: 3, CI: PS1) *Examples of materials to be identified may include baking soda and other powders, metals, minerals, and liquids. Examples of properties may include color, hardness, reflectivity, electrical conductivity, ability to conduct heat, response to magnetic forces, and solubility; density is not intended as an identifiable property.*
5	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Life Science	5L.1.2.1.4 Plan and conduct an investigation to obtain evidence that plants get the materials they need for growth chiefly from air and water. (P: 3, CC: 5, CI: LS1) *Examples of plants may include aquatic plants that grow without soil. Examples of observational evidence may include growth patterns for plants grown in different environments.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
5	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyze and interpret data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Physical Science	5P.2.1.1.1 Analyze and interpret data to show that energy can be transferred from place to place by sound, light, heat, and electric currents. (P: 4, CC: 5, CI: PS3) *Emphasis of the practice is on analyzing student observations and data to serve as evidence to support a claim.*

5	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Physical Science	5P.2.2.1.1 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (P: 5, CC: 3, CI: PS1) *Examples of reactions or changes may include phase changes, dissolving, and mixing to form new substances. Mass and weight are not distinguished.*
5	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	5E.2.2.1.2 Use data to describe patterns in the daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.** (P: 5, CC: 1, CI: ESS1) *Examples of patterns may include the number of daylight hours over the course of a year, selected stars that are visible only in particular months, and the length and direction of shadows over a year.*
5	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Physical Science	5P.3.1.1 1 Develop and refine a model to describe that matter is made of particles too small to be seen. (P: 2, CC: 3, CI: PS1) *Examples of evidence supporting a model may include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.*
5	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Physical Science	5P.3.1.1.2 Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. (P: 2, CC: 5, CI: PS3) *Examples of models may include diagrams, and flow charts.*

Grade	Strand	Substrand	Standard	Content Area	Benchmark
5	3 Develop possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Life Science	5L.3.1.1.3 Create an electronic visualization of the movement of matter among plants, animals, decomposers, and the environment.** (P: 2, CC: 4, CI: LS2) *Emphasis is on the idea that matter that is not food is changed by plants into matter that is food. Examples of systems through which matter cycles may include organisms, ecosystems, and the Earth. Examples of an electronic visualization may include a computer program, simulation, or animation.*

5	12 Exploring phenomena or engineering problems	3.2 Constructing explanations and designing solutions	3.2.1 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others.	Physical Science	5P.3.2.1.1 Construct an explanation based on evidence Relating the speed of an object to the energy of that object. (P: 6, CC: 5, CI: PS3). *The emphasis of the practice is on students identifying the evidence that supports particular points in the explanation. Examples of evidence may include the damage and the height attained when going up a ramp.*
5	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Physical Science	5P.3.2.2 1 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* (P: 6, CC: 5, CI: PS3, ETS1, ETS2) *Examples of devices may include electric circuits that convert electrical energy into motion, light, or sound; and a passive solar heater that converts light into heat. Examples of constraints may include the materials, cost, or time to design the device.*
5	4 Communicate reasons, Arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Earth and Space Science	5E.4.1.1.1 Use evidence to support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth. (P: 7, CC: 3, CI: ESS1) *Evidence may include analogies of light bulbs and distances.*
5	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.2 Students will be able to argue from evidence to justify the best solution to a problem or to compare and evaluate competing designs, ideas, or methods.*	Life Science	5L.4.1.2.1 Evaluate the merit of a solution to a problem caused by changes in plant and animal populations as a result of environmental changes.* (P: 7, CC: 4, CI: LS4, ETS1) *Emphasis is on evaluating solutions (based on evidence and design criteria and constraints), not developing new solutions. Examples of environmental changes may include land characteristics, water distribution, temperature, food availability, or the presence of other organisms.*

Figure 2: Modified MN Dept. of Education curriculum map (all science 68 standards taught by the end of the fourth grade)

Grade	Strand	Substrand	Standard	Content Area	Benchmark
K	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Earth and Space Science	0E.1.1.1.1 Ask questions to obtain information from weather forecasts to prepare for and respond to severe weather.* (P: 1, CC: 7, CI: ESS3, ETS2) *Emphasis is on local forms of severe weather that may arise quickly and should include examples of engineered solutions to severe weather (such as clothing to wear or places to safely shelter).*
K	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Earth and Space Science	0E.1.1.1.2 Ask questions about how a person may reduce the amount of natural resources the individual uses.* (P: 1, CC: 2, CI: ESS3) *Examples of questions may include reusing paper to reduce the number of trees cut down and recycling cans and bottles to reduce the amount of plastic, glass, or metal used.*
K	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	0P.1.2.1.1 Collect and organize observational data to determine the effect of sunlight on Earth's surface. (P: 3, CC: 2, CI: PS3, ETS2) *Examples of Earth's surface may include sand, soil, rocks, and water. Data may be organized in pictographs or bar graphs. Examples of observations may include heating, growth of plants, melting of snow, and shadows.*
K	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Life Science	0L.1.2.1.2 Make observations of plants and animals to compare the diversity of life in different habitats. (P: 3, CC: 1, CI: LS4) *Emphasis is on the diversity of living things in a variety of different habitats and patterns across those habitats.*
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Physical Science	0P.2.1.1.1 Sort objects in terms of natural/human-made, color, size, shape, and texture, then communicate the reasoning for the sorting system. (P: 4, CC: 2, CI: PS1) *Emphasis is on using observations to describe patterns and/or relationships in the natural and designed world in order to answer scientific questions and solve problems.*
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	0E.2.1.1.2 Make daily and seasonal observations of local weather conditions to describe patterns over time.** (P: 4, CC: 1, CI: ESS2) *Examples of qualitative observations may include descriptions of the weather (such as sunny, cloudy, rainy, and warm). Examples of quantitative observations may include numbers of sunny, windy, and rainy days in a month. Examples of patterns may include that it is usually cooler in the morning than in the afternoon and that different months have different numbers of sunny days versus cloudy days in different months.*

K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Life Science	0L.2.1.1.3 Record and use observations to describe patterns of what plants and animals (including humans) need to survive.** (P: 4, CC: 1, CI: LS1) *Examples of patterns may include that animals need to take in food, but plants do not; different animals need different kinds of food; plants require light; and that all living things need water.*
K	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Physical Science	0P.2.2.1.1 Identify and describe patterns that emerge from the effects of different strengths or different directions of pushes and pulls on the motion of an object.** (P: 5, CC: 2, CI: PS2) *Emphasis is on different relative strengths or different directions, but not both at the same time. Examples of pushes or pulls may include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.*
K	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Life Science	0L.3.1.1.1 Develop a simple model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. (P: 2, CC: 4, CI: LS2) *Examples of relationships may include that deer eat buds and leaves, therefore, they usually live in forested areas; and grasses need sunlight, so they often grow in meadows. Examples of models may include food chains, collages, and/or sorting activities.*
K	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Physical Science	0P.3.2.2.1 Design and build a structure to reduce the warming effect of sunlight on Earth's surface.* (P: 6, CC: 2, CI: PS3, ETS1) *Emphasis of the practice is on choosing appropriate materials and tools to solve a problem. Emphasis of the core idea is on understanding the heating effects of sunlight. Examples of structures may include umbrellas, canopies, and tents.*
K	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Physical Science	0P.4.1.1.1 Construct an argument supported by evidence for whether a design solution works as intended to change the speed or direction of an object with a push or a pull.* (P: 7, CC: 2, CI: PS2, ETS1) *Examples of problems requiring a solution may include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions may include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.*
K	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Physical Science	0P.4.2.2.1 Communicate design ideas for a structure that reduces the warming effect of sunlight on Earth's surface.* (P: 8, CC: 2, CI: PS3, ETS1) *Examples of written designs include models, drawings, writing, or numbers.*

1	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Life Science	1L.1.1.1.1 Ask questions based on observations about the similarities and differences between young plants and animals and their parents. (P: 1, CC: 2, CI: LS3) *Examples of observations may include leaves from the same kind of plant are the same shape but can differ in size; and a particular breed of dog looks like its parents but is not exactly the same.*
K* From first grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Physical Science	1P.2.1.1.1 Identify and describe patterns obtained from testing different materials and determine which materials have the properties that are best suited for producing and/or transmitting sound.* (P: 4, CC: 1, CI: PS1, ETS1) *Examples of materials may be wood, paper, string, plastics, cloth, etc.*
K* From first grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	1E.4.2.1.1 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* (P: 8, CC: 4, CI: ESS3) *Examples of human actions that impact the land may include cutting trees to produce paper, using resources to produce bottles, and using water for bathing and brushing teeth. Examples of solutions may include reusing paper and recycling cans and bottles.*
K*. From first grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Life Science	1L.4.2.1.2 Obtain information using various features of texts and other media to determine patterns in the behavior of parents and offspring that help offspring survive. (P: 8, CC: 1, CI: LS1) *Examples of text features include headings, glossaries, electronic menus, pictures, illustrations, icons, etc. Examples of behavior patterns may include the signals that offspring make (such as crying, chirping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).*
1	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	1P.1.2.1.1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. (P: 3, CC: 2, CI: PS4) *Examples of vibrating materials that make sound may include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate may include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.*
1	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	1E.2.2.1.1 Use quantitative data to identify and describe patterns in the amount of time it takes for Earth processes to occur and determine whether they occur quickly or slowly. (P: 5, CC: 7, CI: ESS1) *Emphasis of the core idea is that some Earth processes happen quickly (like tornadoes and thunderstorms) and some slowly (like the erosion of soil). Examples of data may include firsthand observations data from books, videos, pictures, or historical photos.*

1	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Life Science	1L.3.1.1.1 Develop a simple model based on evidence to represent how plants or animals use their external parts to help them survive, grow, and meet their needs. (P: 2, CC: 6, CI: LS1) *Examples of external parts may include acorn shells, plant roots, thorns on branches, turtle shells, animal scales, animal tails, and animal quills.*
1	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Physical Science	1P.3.2.2.1 Design and build a device that uses light or sound to solve the problem of communicating over a distance.* (P: 6, CC: 6, CI: PS4, ETS1, ETS2) *Examples of devices may include paper cup and string "telephones" and a pattern of drum beats.*
1	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Life Science	1L.3.2.2.2 Plan and design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* (P: 6, CC: 6, CI: LS1, ETS2) *Examples of human problems that can be solved by mimicking plant or animal solutions may include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills, and detecting intruders by mimicking eyes and ears.*
1	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Earth and Space Science	1E.4.1.1.1 Construct an argument based on observational evidence for how plants and animals (including humans) can change the non-living aspects of the environment to meet their needs. (P: 7, CC: 4, CI: ESS2) *Examples of plants and animals changing their environment may include a squirrel digging in the ground to hide its food and tree roots breaking concrete.*
1	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.2 Students will be able to argue from evidence to justify the best solution to a problem or to compare and evaluate competing designs, ideas, or methods.*	Earth and Space Science	1E.4.1.2.1 Construct an argument with evidence to evaluate multiple solutions designed to slow or prevent wind or water from changing the shape of the land.* (P: 7, CC: 7, CI: ESS2, ETS2) *Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water; and different designs for using shrubs, grass, and trees to hold back the land.*

1	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Physical Science	1P.4.2.2.1 Communicate solutions that use materials to provide shelter, food, or warmth needs for communities including Minnesota American Indian tribes and communities.* (P: 8, CC: 2, CI: PS1, ETS2) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples of solutions may include past and current building practices that incorporate natural building materials and other green practices as used in sweat lodges, green roofs, moss used for insulation, or sustainable food production and tools used for ricing (harvesting and finishing).*
1*. From 2nd grade	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	2P.1.1.1.1 Ask questions about an object's motion based on observation, that can be answered by an investigation. (P: 1, CC: 1, CI: PS2) *Examples of questions may include what is causing the motion, what type of motion (circular, bouncing, etc.) and what changes are happening in the motion.*
1*. From 2nd grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	2E.2.1.1.1 Represent data to describe typical weather conditions expected during a particular season. (P: 4, CC: 1, CI: ESS2) *Examples of data may include temperature, precipitation, and wind direction. Data displays can include pictographs and bar graphs.*
1*. From 2nd grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	2E.2.1.1.2 Analyze data from tests of objects designed to reduce the impacts of weather-related hazards and compare the strengths and weaknesses of how each performs.* (P: 4, CC: 2, CI: ESS3, ETS1) *Emphasis is on data from tests of student-designed objects. Examples of design solutions to weather-related hazards may include barriers to prevent flooding or snow drifting, structures for sun shading, materials for clothing, and orientation of bus shelters.*
1*. From 2nd grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Physical Science	2P.2.2.1.1 Identify and predict quantitative patterns of the effects of balanced and unbalanced forces on the motion of an object.** (P: 5, CC: F412, CI: PS2) *Examples may include an unbalanced force on one side of a ball can make it start moving; and balanced forces pushing on a box from both sides will not produce any motion at all. Data displays may include pictographs and bar graphs.*
1*. From 2nd grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	2E.4.2.1.1 Obtain and use information from multiple sources to identify where water is found on Earth. (P: 8, CC: 1, CI: ESS2) *Emphasis of the practice is on learning how to use texts and maps to integrate and evaluate content. Examples may include liquid water in oceans, lakes, rivers, and ponds; and solid water in glaciers and polar ice caps.*

2	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	2P.1.2.1.1 Plan and conduct an investigation to describe how heating and cooling affects different kinds of materials based upon their observable properties. (P: 3, CC: 1, CI: PS1) *Examples of materials may include metals, cloth, plastics, styrofoam, wood and glass.*
2	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Physical Science	2P.3.1.1.1 Develop a simple diagram or physical model to illustrate how some changes caused by heating or cooling can be reversed and some cannot.** (P: 2, CC: 2, CI: PS3) *Examples of reversible changes may include materials such as water and butter at different temperatures. Examples of irreversible changes may include cooking an egg, freezing a plant leaf, and heating paper. Examples of diagrams may include a flow chart.*
2	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Life Science	2L.3.2.2.1 Engineer a device that mimics the structures and functions of plants or animals in seed dispersal.* (P: 6, CC: 6, CI: LS2, ETS1) *Emphasis is on how specific structures have particular functions. Examples of seed dispersal by animals may include feeding and subsequent elimination of seeds, or attachment of seeds/pollen to animal structures. Examples of seed dispersal by plants may include various wind-catching designs (as in dandelions or maple trees) or colors and smells that attract pollinators.*
2	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Life Science	2L.4.1.1.1 Construct an argument with evidence that evaluates how in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. (P: 7, CC: 2, CI: LS4, ETS2) *Emphasis is on the interdependence of parts of a system (organisms and their habitat). Examples of habitats should include those found in Minnesota, such as a wetland, prairie, or garden. Examples of evidence may include needs and characteristics of the organisms and habitats involved.*
2	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	2E.4.2.1.2 Obtain and use information from multiple sources, including electronic sources, to describe climates in different regions of the world.** (P: 8, CC: 1, CI: ESS2) *Emphasis of the practice is on learning how to use electronic sources to integrate and evaluate content. Examples of information may include data on an area's typical weather conditions and how these patterns are considered climate.*

2	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Physical Science	2P.4.2.2.1 Obtain information and communicate how Minnesota American Indian Tribes and communities and other cultures apply knowledge of the natural world in determining which materials have the properties that are best suited for an intended purpose.* (P: 8, CC: 2, CI: PS1, ETS1) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Emphasis of the practice is on obtaining, interpreting, and communicating information related to how various cultures have built materials suited for intended purposes according to their properties. Examples of materials may include instruments (Cedar for knockers and Black Spruce for poles) for ricing, birch bark for baskets or other containers for carrying water, and sinew for connecting parts of tools.*
2*. From Third grade	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problem	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	3P.1.1.1.1 Ask questions based on observations about why objects in darkness can be seen only when illuminated. (P: 1, CC: 2, CI: PS4) *Emphasis should be on addressing the misconception that people can see in the dark if they wait long enough and on the way their eyes receive light. Examples of observations may include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight.*
2*. From Third grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	3P.1.2.1 1 Plan and conduct a controlled investigation to determine the effect of placing objects made with different materials in the path of a beam of light. (P: 3, CC: 2, CI: PS4) *Emphasis is on conducting fair tests by controlling variables. Examples of materials may include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).*
2*. From Third grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Life Science	3L.1.2.1.2 Plan and conduct an investigation to determine how amounts of sunlight and water impact the growth of a plant. (P: 3, CC:2, CI: LS2) *Emphasis of the practice is on conducting fair tests and using data to support explanations. Examples of investigations may include simple experiments with fast-growing plants.*
2*. From Third grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Life Science	3L.3.1.1.2 Develop multiple models to describe how organisms have unique and diverse life cycles but all have birth, growth, reproduction, and death in common. (P: 2, CC: 4, CI: LS1) *Emphasis is on the pattern of changes organisms go through during their life. Examples of models may include diagrams, drawings, physical models, or computer programs.*

2*. From Third grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.1 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others.	Life Science	3L.3.2.1.1 Construct an explanation using evidence from various sources for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing. (P: 6, CC: 2. CI: LS4) *Examples of cause and effect relationships may include how individual plants of the same species with different length thorns may be more or less likely to be eaten by predators; or animals that have better camouflage coloration than others of their species may be more likely to survive and therefore more likely to leave offspring.*
2*. From Third grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Life Science	3L.4.2.1.1 Obtain information from various types of media to support an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.** (P: 8, CC: 4, CI: LS1) *Examples of structures may include thorns, stems, roots, colored petals, heart, stomach, lungs, brain, and skin. Examples of media may include electronic sources.*
3	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyzing and interpreting data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Earth and Space Science	3E.2.1.1.1 Record observations of the sun, moon, and stars and use them to describe patterns that can be predicted.** (P: 4, CC: 1, CI: ESS1) *Examples of patterns may include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.*
3	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	3E.2.2.1.1 Organize and electronically present collected data to identify and describe patterns in the amount of daylight in the different times of the year.** (P: 5, CC: 1, CI: ESS1) *Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.*
3	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent the students' understanding of phenomena or systems as they develop questions, predictions and/or explanations, and communicate ideas to others.	Physical Science	3P.3.1.1.1 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. (P: 2, CC: 2, CI: PS4) *Examples of models may include diagrams, drawings, physical models, or computer programs.*
3	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Life Science	3L.4.1.1.1 Construct an argument about strategies animals use to survive. (P: 7, CC: 2, CI: LS2) *Emphasis is on group behavior and how being part of a group helps animals obtain food, defend themselves, and cope with changes. Examples of animals should include wolves or other animals that live in Minnesota.*

3	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Earth and Space Science	3E.4.2.2.1 Gather information and communicate how Minnesota American Indian Tribes and communities and other cultures use patterns in stars to make predictions and plans. (P 8, CC: 1, CI: ESS1) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples may include using star maps to predict seasons, star patterns to inform navigation, and using star stories to identify numeric patterns that guide behavior.*
3*. From fourth grade	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Earth and Space Science	4E.1.1.1.2 Ask questions about how water moves through the Earth system and identify the type of question. (P: 1, CC: 5, CI: ESS2) *Emphasis is on the processes of evaporation, condensation, and precipitation. Examples of types of questions may include those that can be tested by an experiment, and questions that may be answered from a text.*
3*. From fourth grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Earth and Space Science	4E.1.2.1.1 Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.* (P: 3, CC: 2, CI: ESS2) *Emphasis is on predicting the rate of change when variables are changed. Examples of variables to test may include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.*
3*. From fourth grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Earth and Space Science	4E.1.2.1.2 Plan and carry out fair tests in which variables are controlled and failure points are considered to improve a model or prototype to prevent erosion.* (P: 3, CC: 2, CI: ESS2, ETS1; ETS2) *Examples of prototypes to prevent erosion include retaining walls, wind breaks, use of shrubs or other vegetation, and drainage systems.*
3*. From fourth grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	4E.2.2.1.1 Interpret charts, maps and/or graphs of the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** (P: 5, CC: 4, CI: ESS2) *Emphasis is on oceans, lakes, rivers, glaciers, ground water, and polar ice caps.*
3*. From fourth grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Earth and Space Science	4E.3.1.1.1 Develop a model based in part on student observations or data to describe ways the geosphere, biosphere, hydrosphere, and atmosphere interact. (P: 2, CC: 4, CI: ESS2) *Emphasis is on how rock, living things, water, and/or air are individual systems that make up the larger Earth system and interact with each other.*

3*. From fourth grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.1 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others.	Earth and Space Science	4E.3.2.1 1 Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. (P: 6, CC: 1, CI: ESS1) *Examples of evidence from patterns may include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.*
3*. From fourth grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Earth and Space Science	4E.4.2.1.1 Read and comprehend grade appropriate complex texts and/or other reliable media to describe that energy and fuels are derived from natural resources and their uses affect the environment. (P: 8, CC: 2, CI: ESS3, ETS2) *Examples of information about natural resources should include details about those found in Minnesota. Examples of renewable energy resources may include wind, water behind dams, and sunlight; non-renewable energy resources include fossil fuels and fissile materials. Examples of environmental effects may include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution and global warming from burning fossil fuels.*
3*. From fourth grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.1 Students will be able to read and interpret multiple sources to obtain information, evaluate the merit and validity of claims and design solutions, and communicate information, ideas, and evidence in a variety of formats.	Life Science	4L.4.2.1.2 Obtain information from various media sources to determine that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.** (P: 8, CC: 1, CI: LS3) *Emphasis of the practice is to compare and/or combine information across texts and other reliable media. Emphasis is on organisms other than humans and the patterns in traits between offspring and their parents or among siblings.*
3*. From fourth grade	4 Communicating reasons, arguments and ideas to others	4.2 Obtaining, evaluating and communicating information	4.2.2 Students will be able to gather information about and communicate the methods that are used by various cultures, especially those of Minnesota American Indian Tribes and communities, to develop explanations of phenomena and design solutions to problems.	Earth and Space Science	4E.4.2.2.1 Obtain and combine multiple sources of information about ways individual communities, including Minnesota American Indian Tribes and communities and other cultures use evidence and scientific principles to make decisions about the uses of Earth's resources.* (P: 8, CC: 4, CI: ESS3, ETS1) *Examples of cultures may include those within the local context of the learning community and within the context of Minnesota. Examples may include balancing the water, soil, wildlife, plant, and human needs to support sustainable use of resources.*
4	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	4P.1.1.1.1 Ask questions to determine cause and effect relationships of electric and magnetic interactions between two objects not in contact with each other. (P: 1, CC: 2, CI: PS2) *Examples of an electric force may include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force may include the force between two permanent magnets, the force between an electromagnet and steel paper clips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships may include how the distance between objects affects the strength of the force and how the orientation of magnets affects the direction of the magnetic force.*

4	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.2 Students will be able to ask questions about a problem to be solved so they can define constraints and specifications for possible solutions.*	Physical Science	4P.1.1.2.1 Define a simple design problem that can be solved by applying scientific ideas about magnets.* (P: 1, CC: 2, CI: PS2, ETS2) *Examples of problems may include constructing a latch to keep the door shut and creating a device to keep two moving objects from touching each other.*
4	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Earth and Space Science	4E.3.2.2.1 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.* (P: 6, CC: 2, CI: ESS3, ETS1) *Emphasis is on cause and effect relationships to explain change. Examples of solutions may include designing an earthquake resistant building and improving monitoring of volcanic activity.*
4	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Life Science	4L.4.1.1.1 Construct or support an argument that traits can be influenced by different environments. (P: 7, CC: 2, CI: LS3) *Emphasis of the practice is on using evidence, data and/or a model to support an argument. Examples of the environment affecting a trait may include the stunted growth of a typically tall plant grown with insufficient water or an animal's weight being influenced by the availability of food.*
4*. From Fifth Grade	1 Exploring phenomena or engineering problems	1.1 Asking questions and defining problems	1.1.1 Students will be able to ask questions about aspects of the phenomena they observe, the conclusions they draw from their models or scientific investigations, each other's ideas, and the information they read.	Physical Science	5P.1.1.1.1 Ask investigatable questions and predict reasonable outcomes about the changes in energy, related to speed, that occur when objects interact. (P: 1, CC: 5, CI: PS3) *Emphasis is on the change in energy due to a change in speed, not on the forces, as objects interact. Example of a question: Where and how do marbles move after a collision?*
4*. From Fifth Grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	5P.1.2.1.2 Conduct an investigation to determine whether the mixing of two or more substances results in new substances. (P: 3, CC: 2, CI: PS1) *Emphasis is on conducting fair tests by controlling variables.*
4*. From Fifth Grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Physical Science	5P.1.2.1.3 Evaluate appropriate methods and tools to identify materials based on their properties prior to investigation. (P: 3, CC: 3, CI: PS1) *Examples of materials to be identified may include baking soda and other powders, metals, minerals, and liquids. Examples of properties may include color, hardness, reflectivity, electrical conductivity, ability to conduct heat, response to magnetic forces, and solubility; density is not intended as an identifiable property.*
4*. From Fifth Grade	1 Exploring phenomena or engineering problems	1.2 Planning and carrying out investigations	1.2.1 Students will be able to design and conduct investigations in the classroom, laboratory, and/or field to test students' ideas and questions, and will organize and collect data to provide evidence to support claims the students make about phenomena.	Life Science	5L.1.2.1.4 Plan and conduct an investigation to obtain evidence that plants get the materials they need for growth chiefly from air and water. (P: 3, CC: 5, CI: LS1) *Examples of plants may include aquatic plants that grow without soil. Examples of observational evidence may include growth patterns for plants grown in different environments.*

4*. From Fifth Grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.1 Analyze and interpret data	2.1.1 Students will be able to represent observations and data in order to recognize patterns in the data, the meaning of those patterns, and possible relationships between variables.	Physical Science	5P.2.1.1.1 Analyze and interpret data to show that energy can be transferred from place to place by sound, light, heat, and electric currents. (P: 4, CC: 5, CI: PS3) *Emphasis of the practice is on analyzing student observations and data to serve as evidence to support a claim.*
4*. From Fifth Grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Physical Science	5P.2.2.1.1 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (P: 5, CC: 3, CI: PS1) *Examples of reactions or changes may include phase changes, dissolving, and mixing to form new substances. Mass and weight are not distinguished.*
4*. From Fifth Grade	2 Looking at data and empirical evidence to understand phenomena or solve problems	2.2 Using mathematics and computational thinking	2.2.1 Students will be able to use mathematics to represent physical variables and their relationships; compare mathematical expressions to the real world; and engage in computational thinking as they use or develop algorithms to describe the natural or designed worlds.	Earth and Space Science	5E.2.2.1.2 Use data to describe patterns in the daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.** (P: 5, CC: 1, CI: ESS1) *Examples of patterns may include the number of daylight hours over the course of a year, selected stars that are visible only in particular months, and the length and direction of shadows over a year.*
4*. From Fifth Grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Physical Science	5P.3.1.1 1 Develop and refine a model to describe that matter is made of particles too small to be seen. (P: 2, CC: 3, CI: PS1) *Examples of evidence supporting a model may include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.*
4*. From Fifth Grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Physical Science	5P.3.1.1.2 Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. (P: 2, CC: 5, CI: PS3) *Examples of models may include diagrams, and flow charts.*
4*. From Fifth Grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.1 Developing and using models	3.1.1 Students will be able to develop, revise, and use models to represent their understanding of phenomena or systems as they develop questions, predictions and/or explanations and communicate ideas to others.	Life Science	5L.3.1.1.3 Create an electronic visualization of the movement of matter among plants, animals, decomposers, and the environment.** (P: 2, CC: 4, CI: LS2) *Emphasis is on the idea that matter that is not food is changed by plants into matter that is food. Examples of systems through which matter cycles may include organisms, ecosystems, and the Earth. Examples of an electronic visualization may include a computer program, simulation, or animation.*

4*. From Fifth Grade	12 Exploring phenomena or engineering problems	3.2 Constructing explanations and designing solutions	3.2.1 Students will be able to apply scientific principles and empirical evidence (primary or secondary) to explain the causes of phenomena or identify weaknesses in explanations developed by the students or others.	Physical Science	5P.3.2.1.1 Construct an explanation based on evidence relating the speed of an object to the energy of that object. (P: 6, CC: 5, CI: PS3). *The emphasis of the practice is on students identifying the evidence that supports particular points in the explanation. Examples of evidence may include the damage and the height attained when going up a ramp.*
4*. From Fifth Grade	3 Developing possible explanations of phenomena or designing solutions to engineering problems	3.2 Constructing explanations and designing solutions	3.2.2 Students will be able to use their understanding of scientific principles and the engineering design process to design solutions that meet established criteria and constraints.*	Physical Science	5P.3.2.2 1 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* (P: 6, CC: 5, CI: PS3, ETS1, ETS2) *Examples of devices may include electric circuits that convert electrical energy into motion, light, or sound; and a passive solar heater that converts light into heat. Examples of constraints may include the materials, cost, or time to design the device.*
4*. From Fifth Grade	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.	Earth and Space Science	5E.4.1.1.1 Use evidence to support an argument that the apparent brightness of the sun and stars is due to their relative distances from Earth. (P: 7, CC: 3, CI: ESS1) *Evidence may include analogies of light bulbs and distances.*
4*. From Fifth Grade	4 Communicating reasons, arguments and ideas to others	4.1 Engaging in Arguing from evidence	4.1.2 Students will be able to argue from evidence to justify the best solution to a problem or to compare and evaluate competing designs, ideas, or methods.*	Life Science	5L.4.1.2.1 Evaluate the merit of a solution to a problem caused by changes in plant and animal populations as a result of environmental changes.* (P: 7, CC: 4, CI: LS4, ETS1) *Emphasis is on evaluating solutions (based on evidence and design criteria and constraints), not developing new solutions. Examples of environmental changes may include land characteristics, water distribution, temperature, food availability, or the presence of other organisms.*