Elementary Scope and Sequence

August 2026

Overview

The OpenSciEd Elementary Scope and Sequence describes how the program of kindergarten through fifth-grade units addresses the *Next Generation Science Standards* (NGSS). The program consists of 24 units, four in each grade, kindergarten through fifth grade. In this document, teachers, curriculum specialists, coaches, and administrators can find the rationale for OpenSciEd's mapping of all K-5 NGSS performance expectations (PEs) to these 24 units, and the rationale for the scope and sequence of the program.

The OpenSciEd Elementary program emphasizes the central goal of the *A Framework for K-12 Science Education (The Framework)* and NGSS, moving from students "learning about" science to supporting students in "figuring out the science." OpenSciEd is designed to help students develop science ideas and practices in ways that they see as connected to their own questions and to what they have already figured out. In each grade level, students build on the ideas and practices they figured out in prior years, as well as on their own lived experiences. This document outlines how the program helps students progressively build understanding of the three dimensions of the NGSS: science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) over time, and where these trajectories place several constraints on the otherwise flexible ordering of units within a year. In particular, this document explains:

- how the units address all NGSS performance expectations (PEs) for Grades K-5;
- how and why grade level PEs are bundled into the four coherent units per year; and
- how the program supports students in developing the three dimensions of NGSS in each unit, and
- how each dimension builds on the work of earlier units within grade and of earlier grades.

How do we bundle NGSS PEs by grade and units within grade?

NGSS organizes performance expectations for K-5 by grade, articulating PEs for each individual grade K, 1, 2, 3, 4, and 5 (except for engineering performance expectations, which are assigned to the grade bands K-2 or 3-5). Within each grade, we created four units by grouping related PEs together so that we could develop a meaningful context for the unit in which students can develop and apply the target ideas and practices. We bundled together PEs that address related science ideas, such as combining patterns of the Sun, Moon, and stars in the sky with seasonal patterns of sunrise and sunset (Unit 1.3). We also grouped ideas across scientific disciplines (e.g., physical science and Earth/space science) where we felt these ideas could be addressed coherently in the same context. For example, we combined the physical science idea of how waves cause an object to move with the earth science idea of weathering and erosion (Unit 4.3), so that students could explain why water moving against land could cause these patterns. In this process, we drew on earlier K-5 development work by members of the OpenSciEd Developers Consortium (Next Generation Science Storylines, SOLID Start, and PeBLES2). We also consulted with our state steering committee and science leaders at OpenSciEd on potential unit contexts.

Figure 1 shows how OpenSciEd organizes the NGSS PEs into bundles for the 24 units in the K-5 program. Each of the six grades (K through 5) is depicted as a column from left to right. The recommended sequence of units follows the order of unit numbers in each grade (e.g. Unit 1.1, 1.2, 1.3, and 1.4). Arrows connecting units show important connections of disciplinary core ideas, indicating that teachers of the unit in the later grade should help students connect to and build on ideas from the unit in the earlier grade (e.g., 1.2 → 4.2 and K.4 → 2.4), as is supported in the teacher guides.

In order to accommodate sharing classroom materials in schools or districts with multiple sections of each grade, most units can be taught in different orders within the grade. Arrows between consecutive units (e.g., 3.3 → 3.4) indicate a few exceptions to this flexibility within grade, where the logical building of ideas suggests a preferred order. Full guidance about flexible sequencing of units is provided in Appendix E.

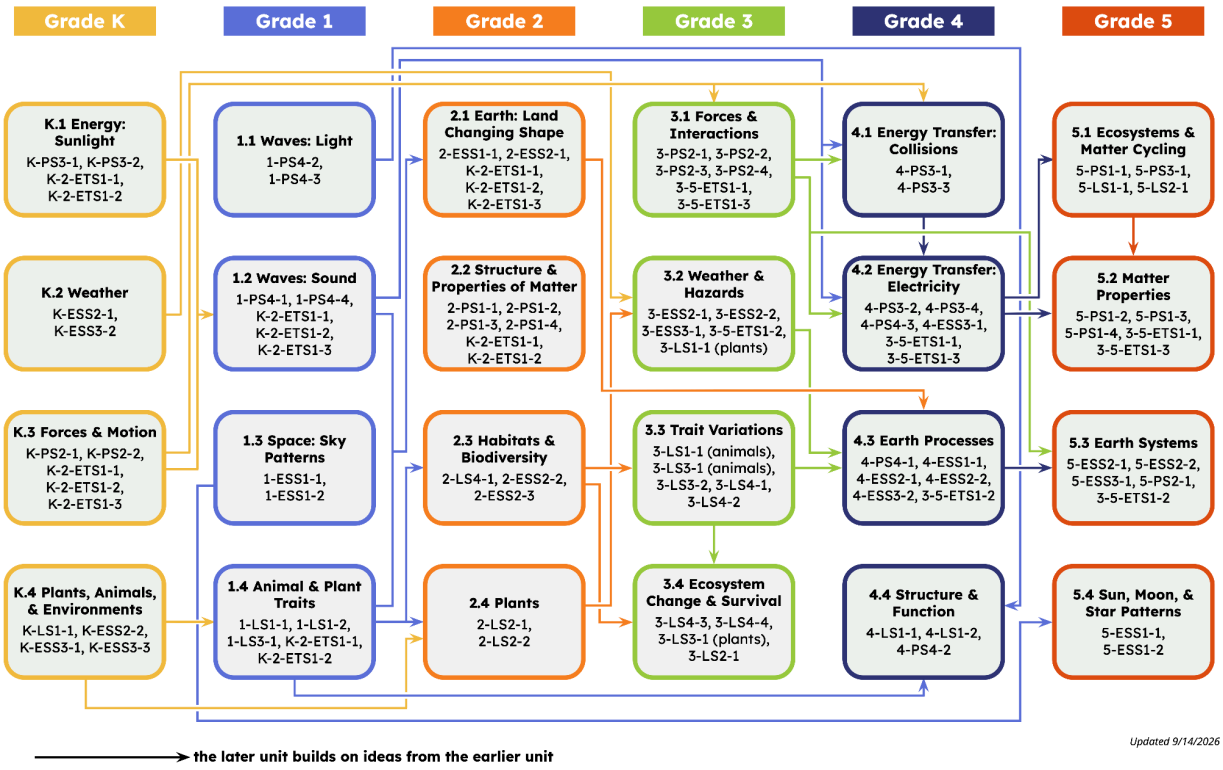


Figure 1: Scope and sequence map of NGSS performance expectations for each unit.

How do learning pathways within and across grades?

The Framework for K-12 Science Education and NGSS emphasizes the need for coherence and the intentional building of all three dimensions as necessary for equitable science education. OpenSciEd Elementary materials value and build on the knowledge and experiences of all students as they progress from grade to grade. This development of ideas is critical for making science more meaningful for students and helping them develop deeper and more generative science ideas and practices.

Helping students connect what they are learning to what they have already figured out, both from their prior classroom learning and from their everyday experience, is a key part of the research-based learning approach underlying the *Framework* and NGSS. For such cross-grade connections shown in Figure 1, the sequencing is already assumed from the grade assignments in NGSS performance expectations, e.g., 1.4, 2.3, and 3.4 in grades 1, 2, and 3 respectively. The importance of these arrows in the scope and sequence is to indicate where the design of activities and discussions guides teachers in helping students connect the ideas they are building in the current unit to what they have figured out in

earlier units. This guidance is provided in each unit's Front Matter section, as well as in the specific lesson teacher guides where it is relevant.

For example, the connection 2.3 → 3.4 in Figure 1 indicates an important way to leverage students' work with habitats in second grade (Unit 2.3) in their work in third grade. In unit 3.4, when the class is trying to figure out how habitats support living things in the context of the underwater places where dolphins and manatees live, the teacher asks students to draw on what they learned in Unit 2.3 about land-based habitats as a starting point. Similarly, the connection 2.4 → 3.2 indicates that teachers should support students in using ideas they figured out about plants in Unit 2.4 in Unit 3.2. In Unit 3.2, when the class has an initial ideas discussion to surface what they already know about how fruits and vegetables grow (leading to what they will figure out in the unit about plant life cycles), students are prompted to bring ideas they learned in Unit 2.4 about plant parts and needs.

The OpenSciEd Elementary program includes a few cases where students are supported in building science ideas by drawing on important things they figured out about these ideas in earlier units of that same grade level, when following the recommended sequence. This designed sequence enables students to build ideas in more natural order, for example, building more complex ideas on simpler or easier to understand ideas, or developing ideas in more familiar contexts first.

For example, in third grade, Unit 3.3 Trait Variations should be taught before Unit 3.4 Ecosystem Change & Survival. Students can more easily observe trait variations and make sense of inheritance patterns in animals than in plants, so they address this idea with animals in Unit 3.3 first. Then students are ready to figure out in Unit 3.4 whether the same ideas can apply to plant trait variations and inheritance, which can be more difficult to observe.

Similarly, in fourth grade, Unit 4.1 Energy Transfer: Collisions should be taught before Unit 4.2 Energy Transfer: Electricity. In Unit 4.1, students figure out that sound, heat, and changes in motion are evidence of energy transfer in collisions. Phenomena such as the sound of an impact, heat given off by rubbing things together, and changes in motion of an object from a collision are easy for fourth grade students to observe. Furthermore, these ideas fit with the intuitive sense of cause and effect students are likely to bring in from everyday experience, e.g., collisions can make sound. Then, in Unit 4.2, students can build on what they figured out in Unit 4.1 to make sense of energy transfer via electricity and light, where the cause and effect relationship is less obvious and more complex to figure out.

Appendix A provides detailed explanations for how each unit builds on what students have figured out about the DCIs in prior units and why this is the recommended unit sequencing. However, if local conditions make it necessary to teach one of these units out of the recommended sequence, pay close attention to the guidance in those units' *Front Matter* sections. You will need to plan for additional instructional support and class time for students to construct ideas coherently since they will not have figured out some of the building blocks in a prior unit. Appendix E of this document also provides additional guidance about rearranging units and the options for flexible sequencing.

Why are some PEs addressed in multiple units?

Although most PEs occur in a single unit, two biology PEs are split between units. As we developed coherent phenomena-based units in third grade, we found that for two concepts, heredity (3-LS1-1) and life cycles (3-LS3-1), investigations of these ideas would be better suited to different phenomena contexts for plants and animals. Therefore, we split each of these PEs into a plant and an animal part and addressed them in different unit contexts. The focus for each of these divided PEs is indicated in parentheses in Figure 1 (see Units 3.2, 3.3, and 3.4).

Defining Progressions for the Three Dimensions

A key innovation in the *Framework* and the NGSS is that, in addition to supporting students in building the DCIs coherently over the K-12 learning experience, students are also expected to build and deepen their use of SEPs and CCCs as well. To accomplish this, students learn to use the science and engineering practices along with the crosscutting concepts, in concert with disciplinary core ideas, *throughout* their scientific work in OpenSciEd units. To ensure that these dimensions are just as important to student learning as the DCIs, SEPs and CCCs are intentionally developed and practiced across grade levels.

SEPs and CCCs are Intentionally Developed and Practiced

Students are not expected to develop proficiency in using an SEP or CCC in a single unit. We structured the OpenSciEd Elementary program to provide support for students to build continually on what they have figured out already with science and engineering practices and crosscutting concepts. Over the course of multiple units and across grade levels, students have repeated opportunities to engage with different elements of practices and concepts in different contexts. However, because the NGSS uses the same eight SEPs and seven CCCs across the entire K-12 trajectory, it would be too cumbersome to have Figure 1 depict the many connections between units arising from building on SEPs and CCCs.

Therefore, Figure 1 depicts just those connections involving disciplinary core ideas. Instead, we make the trajectory of practices and crosscutting concepts explicit by identifying the treatment of central SEPs and CCC for each unit as Intentionally Developed or Opportunities to Practice. (Other SEPs and CCCs not present in the unit are "Not Claimed.")

When a unit **Intentionally Develops** an SEP or CCC, lessons include guidance for teachers to explicitly motivate and talk through that idea or practice with students. The lessons include scaffolding that can be later removed to build independence, and are typically assessed in formative and/or summative ways. Each lesson's Learning Goals identify which elements of the SEPs and CCCs are the focus for that lesson. All SEPs and CCCs that are associated with performance expectations are intentionally developed in their respective grade levels, and the elements tied to each PE are used in their respective units. Additional SEPs and CCCs are intentionally developed across grade bands when they are useful in making sense of science ideas and so that students have foundational experience with them in order to build on them in later grades.

We identify **Opportunities to Practice** an SEP or CCC when students authentically use elements of those practices or concepts in the work of the unit but without specific scaffolds or supports across lessons. SEPs and CCCs identified as Opportunities to Practice may or may not be used in lesson-level Learning Goals or assessments, but students draw on these ideas and practices to support their work in the unit.

As described in the NGSS, "the eight practices are not separate; they intentionally overlap and interconnect" (NGSS, Appendix F, p. 3). Consequently, students may use SEPs and CCCs other than those identified in lesson-level Learning Goals. These additional uses of the SEPs and CCCs are not a focus of the unit learning, but students may apply these practices or concepts to accomplish their work in the unit. For those SEPs or CCCs that students do not need to support their work in a unit, we note these as **"Not Claimed"** (Appendices C, D).

By coordinating the intentional development of SEPs and CCCs along with opportunities to practice them across units, grade levels, and grade bands, students build a deep understanding of these practices and concepts and work toward using them in more complex ways across the program. Since the K-5 units are designed to provide some flexibility in sequencing within grades, we do not expect a sequence of always intentionally developing a CCC or SEP in a unit before students have an opportunity to practice it in a following unit. Instead, units are designed to give students multiple experiences using an SEP or CCC in varied contexts, and provide guidance for teachers to support students in using SEPs and CCCs even if they have not intentionally developed them in a prior unit. The

following tables 1.A, 1.B, and 1.C elaborate these definitions and provide examples of each. Appendix B provides more elaborated descriptions of these criteria.

Table 1.A. Intentionally Developing a Science & Engineering Practice or Crosscutting Concept

Unit Design	In the Classroom
The unit… …explicitly introduces the SEP or CCC to students, guided by the elements at that grade band. …supports a gradual release of scaffolds toward more independent student use of the SEP or CCC as described by elements at that grade band. …uses elements of this SEP or CCC in lesson-level Learning Goals, especially focusing on those identified in the unit's PE bundle. …provides an opportunity to use the SEP or CCC to make sense of ideas in the context of a new anchoring phenomenon …repeats use of specific elements across lessons and/or in varied contexts within the unit, such as during transfer tasks in grades 3-5. …contains multiple assessment opportunities for elements of this SEP or CCC. …often includes not-yet-used elements of the SEP or CCC.	***Students…*** … learn and use new aspects of the SEP or CCC (e.g., a new element or applying it to new contexts to figure out new phenomena). … are supported by resources like checklists or organizers, explicit discussions, books, etc. …gradually progress to more independent use of the SEP or CCC (such as working first with the whole class, then with small groups and/or partners, then independently). …are assessed on this SEP or CCC as part of a 3D assessment, aligned with the elements used in the unit's PEs. ***Teachers…*** …engage students in tasks and explicit discussions using the SEP or CCC, introducing a new element or its use in new kinds of phenomena. …provide feedback on students' use of the SEP or CCC guided by elements at that grade band.
Examples	
Unit K.1 Energy: Sunlight *intentionally develops* the SEP of Planning and Carrying Out Investigations. The unit provides explicit instruction and scaffolding to support students in making firsthand observations to collect data that can be used to make comparisons about different outdoor surfaces and to determine how well their proposed solutions solve the problem of helping the blacktop stay less hot. Unit 3.3 Trait Variations *intentionally develops* the CCC of Scale, Proportion, and Quantity. This concept is used as students make sense of fossil evidence in relation to animals and places today and those of very long ago. The unit uses scaled timeline representations to support students in understanding the immense scale of time for fossil records compared to the scale of time for their own personal history. Unit 5.4 Sun, Moon, & Star Patterns *intentionally develops* the SEP of Analyzing and Interpreting Data. Throughout the unit, students are supported in representing data in a variety of graphical displays to reveal patterns and	

make sense of phenomena. The class reads a book about data displays, and students use a web-based analysis tool to create different graphical displays to help them figure out how the Sun appears to move across the sky.

Table 1.B. Opportunities to Practice a Science & Engineering Practice or Crosscutting Concept

Unit Design	In the Classroom
The unit… …provides opportunities for students to have experience working with the SEP or CCC because it is necessary for their sensemaking. …may include elements of the SEP or CCC in some lesson-level Learning Goals. …may offer occasional assessment opportunities for elements of the SEP or CCC. ***But, the unit…*** … does not explicitly scaffold or support use of the SEP or CCC. …may not offer repeated opportunities to use the SEP or CCC.	***Students…*** …use the SEP or CCC in ways that are not substantially different in the elements they draw on or the contexts they are used in from earlier units. …use the SEP or CCC as a way to reinforce their understanding of that SEP or CCC. …may use the SEP or CCC to support their science work without explicit or formal prior use. ***Teachers…*** …continue to provide support and feedback for students on their use of the SEP or CCC, but in less formal ways. … may continue or fade scaffolding for the SEP or CCC (if appropriate).

Examples

Unit K.1 Energy: Sunlight provides an *opportunity to practice* the SEP of Developing and Using Models. Students draw diagrams to communicate their ideas about why some surfaces are hot and why others are less hot, and to share their design solutions with classmates. However, these drawings are not explicitly called "models" yet, and instructional time is not spent defining the practice of modeling and distinguishing it from other types of drawing.

Unit 3.3 Trait Variations includes *opportunities to practice* the SEP of Using Mathematics and Computational Thinking. A few times in the unit, students organize simple data sets to reveal patterns that suggest relationships, but they are not expected to do this independently, and this work is not assessed.

Unit 4.4 Structure & Function provides an *opportunity to practice* using the CCC of Cause and Effect. Students investigate and use cause-and-effect relationships to explain what causes a flying squirrel to be able to see objects in low amounts of light. Students work with small groups, and there are two formative assessment opportunities to use this concept, but students are not using it in a significantly different way than earlier units.

Table 1.C. Science & Engineering Practice or Crosscutting Concept Not Claimed in Unit

Unit Design	In the Classroom
The unit… …may briefly mention use of an SEP or CCC as part of the work students do, or …may not mention use of the SEP or CCC at all.	***Students…*** … may generally use the SEP or CCC, or … may not be asked to use the SEP or CCC in this unit. ***Teachers…*** … do not focus instruction or scaffolding on the SEP or CCC.

Examples

The SEP of Planning and Carrying Out Investigations is *not claimed* in Unit K.4; it is not mentioned in the unit's Alignment with the Three Dimensions of NGSS matrix, nor is it used in any lesson-level Learning Goals. However, students do engage in investigations in multiple ways during the unit in order to figure out important science ideas.

The SEP of Analyzing and Interpreting Data is *not claimed* in Unit 5.3; it is only mentioned twice in the unit's Alignment with the Three Dimensions of NGSS matrix, but not used in any lesson-level Learning Goals. Students do analyze and interpret data during the unit, but in service of intentionally developing other concepts and practices (in this case, Using Mathematics and Computational Thinking).

The CCC of Energy and Matter is *not claimed* in any of the third grade units because students do not use this crosscutting concept to help make sense of science ideas at that grade level. In this grade band, the elements specify conceptual understanding of energy transfer (not developed in the DCIs until fourth grade) and the particulate nature of matter (not developed in the DCIs until fifth grade).

Tables 2-5 on the following pages summarize the status of progression for each SEP and CCC in OpenSciEd Elementary, identifying those units that Intentionally Develop, provide Opportunities to Practice, or do not claim it (empty cells). Appendix C provides full details of how OpenSciEd supports developing each SEP across the program, and Appendix D outlines how OpensciEd supports developing each CCC across the program.

Table 2. Summary of the Progression for the SEPs in Grades K-2

Unit	Asking Questions & Defining Problems	Developing & Using Models	Planning & Carrying Out Investigations	Analyzing & Interpreting Data	Using Math & Computational Thinking	Construct. Explanations & Designing Solutions	Engaging in Argument from Evidence	Obtaining, Evaluating & Comm. Info.
K.1	○	○	●	●		●	○	○
K.2	●			●	●			●
K.3	○	○	●	●	○	○		○
K.4		●		○			●	●
1.1	○	●	●	○	○	●	○	○
1.2	○	●	●	○		●		○
1.3	○		●	●	●		●	○
1.4	○	○	○		○	●		●
2.1	●	●	○	●		●	●	○
2.2	○	●	○			●	●	
2.3	○	●	●	○				●
2.4	○	●	●	○	●			

● **Intentionally Developed** ○ **Opportunities to Practice**

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Table 3. Summary of the Progression for the SEPs in Grades 3-5

Unit	Asking Questions & Defining Problems	Developing & Using Models	Planning & Carrying Out Investigations	Analyzing & Interpreting Data	Using Math & Computational Thinking	Construct. Explanations & Designing Solutions	Engaging in Argument from Evidence	Obtaining, Evaluating & Comm. Info.
3.1	●	●	●	○		○		○
3.2	○	○		●	○	●	●	●
3.3	○	●		●	○	●		○
3.4	○	○		●		○	●	●
4.1	●	○	●	○		●		
4.2	●	○	●		○	●	○	●
4.3	○	●	●	●		●		○
4.4	○	●				○	●	○
5.1	○	●	○	○			●	○
5.2	●	○	●		○	●		○
5.3		●			●	○	○	●
5.4	○	○		●	○		●	○

● **Intentionally Developed** ○ **Opportunities to Practice**

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Table 4. Summary of the Progression for the CCCs in Grades K-2

Unit	Patterns	Cause and Effect	Scale, Proportion, and Quantity	Systems and Systems Models	Energy and Matter	Structure and Function	Stability and Change
K.1	●	●	○			○	
K.2	●	●	○				
K.3	●	●	○			○	
K.4	○	●		●			
1.1		●					
1.2	○	●				●	
1.3	●	○	○				
1.4	●		○			●	
2.1	●	○	○			●	●
2.2	●	●			●	●	
2.3	●		●	○			
2.4		●	○	○		●	

● **Intentionally Developed** ○ **Opportunities to Practice**

Table 5. Summary of the Progression for the CCCs in Grades 3-5

Unit	Patterns	Cause and Effect	Scale, Proportion, and Quantity	Systems and Systems Models	Energy and Matter	Structure and Function	Stability and Change
3.1	●	●	○	●		○	
3.2	●	●	○	○		○	
3.3	●	●	●				○
3.4	●	●		●			○
4.1	○	●		○	●		
4.2	●	●	○		●		
4.3	●	●	○				
4.4	○	○		●		●	
5.1	●		●	●	●		
5.2		●	●		●		
5.3	○	●	●	●			○
5.4	●	○	●				●

● **Intentionally Developed** ○ **Opportunities to Practice**

How to use the Scope and Sequence Appendices

This document provides guidance about how each unit contributes to the development of and/or draws on what students have already figured out about elements of the DCIs, CCCs, and SEPs to fully prepare students to meet the performance expectations defined by the NGSS. The figure and tables above summarize the progressions for each of the three NGSS dimensions, DCIs (Figure 1), SEPs (Tables 2 and 3), and CCCs (Tables 4 and 5). The appendices provide more detailed explanations of the information in the figure and tables.

Teachers and administrators can use the information articulated in these appendices to guide their planning for implementation of units across grades and grade bands. When preparing to teach the units in a grade, it is helpful to review the scope and sequence to see the trajectory of ideas in the grade, and identify the important connections teachers will need to help students build within the grade and from earlier grades. Schools or districts can use these appendices to develop their own scope and sequence if they plan to customize the OpenSciEd Elementary recommended sequence.

The information in these appendices is drawn from the explanations in each unit's Alignment with the Three Dimensions of NGSS matrix and Unit Overview document. These appendices pull together that information and connect it across units to tell the story of how students build each dimension step by step in each grade band.

- Appendix A: DCI Progressions: This appendix explains how some DCI elements involve building upon what students figured out in earlier units, expanding on the DCI-based arrows in the Scope and Sequence map (Figure 1).
- Appendix B: How OpenSciEd Units Support the Progressions of SEPs and CCCs: This appendix expands on Table 1 to define what you will see in each unit in terms of the guidance provided and the expectations for prior learning when the unit intentionally develops or provides an opportunity to practice an SEP or CCC.
- Appendix C: SEP Progressions: This appendix describes how students build each SEP across units in each grade band, detailed in terms of NGSS elements of SEPs.
- Appendix D: CCC Progressions: This appendix describes how students build each CCC across units in each grade band, detailed in terms of NGSS elements of CCCs.
- Appendix E: Guidance for Flexible Sequencing: This appendix provides information about how units can be rearranged within grade levels for schools or districts who want to share classroom materials across sections of each grade.

Additional resources on the history and rationale of OpenSciEd Elementary

For more information about the pedagogical approach in OpenSciEd Elementary School that this Scope & Sequence supports, see the *OpenSciEd Elementary Teacher Handbook*.

For the history and overall approach of the OpenSciEd project (focused on middle school), download this article (free access):

> Edelson, D. C., Reiser, B. J., McNeill, K. L., Mohan, A., Novak, M., Mohan, L., Affolter, R., McGill, T. A. W., Bracey, Z. E. B., Noll, J. D., Kowalski, S., Novak, D., Lo, A. S., Landel, C., Krumm, A., Penuel, W. R., Horne, K. V., González-Howard, M., & Suárez, E. (2021). Developing research-based instructional materials to support large-scale transformation of science teaching and learning: The approach of the OpenSciEd middle school program. *Journal of Science Teacher Education*, 32(7), 780-804. https://doi.org/10.1080/1046560X.2021.1877457

To learn more about storyline pedagogical approach used in this program developed by Brian Reiser, Michael Novak, Tara McGill, and the NextGen Science Storylines group, read:

> Reiser, B. J., Novak, M., McGill, T. A. W., & Penuel, W. A. (2021). Storyline units: An instructional model to support coherence from the students' perspective. *Journal of Science Teacher Education*, 32(7), 805-829. https://doi.org/10.1080/1046560X.2021.1884784
>
> McGill, T. A. W., Housman, G., & Reiser, B. J. (2021). Motivating three-dimensional learning from students' questions: Supporting elementary students' three-dimensional learning about waves with a storyline unit. *Science and Children*, 59(1), 54-59. https://www.nsta.org/science-and-children/science-and-children-septemberoctober-2021/motivating-three-dimensional

OpenSciEd Elementary is also informed by the work of the SOLID Start program, and Grades K-2 units were built on units originally designed by Amelia Wenk Gotwals, Tanya S. Wright, and others on that team. To learn more about SOLID Start and the integration of literacy and science in the primary grades, see:

> Wright, T. S. & Gotwals, A. W. (2017). Supporting kindergartners' science talk in the context of an integrated science and disciplinary literacy curriculum. *The Elementary School Journal*, 117, 513-537.
>
> Wright, T. S., Gotwals, A. W., & Pikus, A. (2026). Supporting teachers to enact science talk in early elementary classrooms: The role of professional learning and curriculum. *Early Childhood Research Quarterly*, 74, 232-241.

Fitzgerald, M., Bismack, A., Gotwals, A. W., & Wright, T. S. (July/August 2022). Modeling, reading, and talking, oh my! Using multiple modes to promote sensemaking and scientific literacy in the early elementary grades. *Science and Children.* 48-53.

Appendix A: Progressions of Disciplinary Core Ideas

In this appendix, we describe how supporting students in the DCIs relies on making connections to what students figured out in earlier units. First, we expand on the Scope and Sequence diagram in Figure 1 to identify how each unit builds on the work of prior units to develop the disciplinary core ideas as reflected in the NGSS performance expectations. In the first section, we describe the connections between units needed to build the depth of understanding of the DCIs called out in the PEs and supported in OpenSciEd Elementary. We consider these connections central to the coherent building of ideas within and across grades.

Second, we describe a number of optional connections that students might also make between ideas in the units. These optional connections reflect potential connections between ideas not required to build the DCIs as used in the NGSS PEs, connections between context-specific applications of the science not central to the PEs, or connections students might notice that are made in NGSS in a higher grade band (e.g., middle school).

Building essential DCI connections across units (Figure 1 arrows)

The collection of disciplinary core ideas articulated by the *Framework*, and reflected in NGSS, describe a coherent learning trajectory from kindergarten through twelfth grade. The performance expectations in NGSS reflect these trajectories, and outline how students can build deeper and more elaborated understandings by connecting what they are figuring out to ideas they built in earlier science learning, both within the year and in prior years. For example, in kindergarten, students figure out that plants and animals get what they need to survive and grow from the environment, and then in first grade build on that understanding to figure out that plants and animals have special parts that enable them to get what they need from the environment (see the first row in Table A.1).

These important connections are indicated with arrows in Figure 1. The learning story behind these arrows is expanded here in Tables A.1-A.4. These tables reflect the four science domains of the DCIs: life sciences (LS, Table A.1); physical sciences (PS, Table A.2); Earth and space sciences (ESS, Table A.3); and engineering, technology, and applications of science (ETS, Table A.4). Each row of the table reflects a pathway through these trajectories, some spanning two units (e.g., K.4 → 2.4), and some spanning multiple units across grades (e.g., K.4 → 1.4 → 2.3 → 3.4).

The top half of each row depicts the NGSS PEs that are involved in building the DCIs along the trajectory in those units. Next shown are the DCI components (e.g., ESS2.E and LS1.C) that build upon one another across the units in the trajectory. The detailed text listed with

the DCI component is the element, or specific part, of that DCI built in one of the units (shown in brackets). For example, part of LS4.D is developed in Unit 2.3, and another part builds on that idea and is developed in Unit 3.4. The trajectory or story of how the units support students in incrementally building these ideas is described, unit by unit, in the bottom half of each row.

The rows are ordered to capture the arrows in Figure 1 that start in each grade level, from earlier in the year to later. For example, there are two trajectories relevant to life sciences DCIs that begin in kindergarten, both arrows coming from K.4. The first row captures the connection from K.4 to 1.4 (that continues to additional units), and the second row captures the connection from K.4 to 2.4.

Table A.1 Building DCI Connections in Life Sciences

Units	Progression of DCIs in Life Sciences Across Units
K.4 → 1.4 → 2.3 → 3.4	***PEs:*** *K-ESS2-2, K-ESS3-1, K-LS1-1, 1-LS1-1, 2-LS4-1, 3-LS4-4* ***ESS2.E Biogeology*** *Plants and animals can change their environment. [K.4]* ***ESS3.A Natural Resources*** *Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. [K.4]* ***LS1.C Organization for Matter and Energy Flow in Organisms*** *All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. [1.4]* ***LS1.A Structure and Function*** *All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. [1.4]* ***LS4.D Biodiversity and Humans*** *There are many different kinds of living things in any area, and they exist in different places on land and in water. [2.3]* ***LS4.D Biodiversity and Humans*** *Populations live in a variety of habitats, and change in those habitats affects the organisms living there. [3.4]*

Units	Progression of DCIs in Life Sciences Across Units
	Progression of ideas: How parts help plants and animals meet their needs in habitats **In Unit K.4**, students consider whether birds and other animals need help from humans, so they make sense of animal needs (food, water, air, and homes) and plant needs (water and sunlight). They also make observations of animals and plants changing their environments to meet those needs (e.g., birds using plant parts to make nests, a tree breaking pavement nearby). **In Unit 1.4**, students build on these ideas from Unit K.4 when they investigate how plants and animals use specific parts to help them meet those needs to live and grow (e.g., carnation stems bring water to the leaves and flower, different-shaped beaks help birds get certain types of food). **In Unit 2.3**, students make observations about how plants and animals in an area (habitat) are similar or different, using ideas about different plant and animal parts from Unit 1.4 to help them compare and contrast (e.g., leaf shape, color of scales, etc.). They define a "habitat" as a natural environment where animals and plants live and grow. **In Unit 3.4**, the class extends their ideas about habitats from Unit 2.3 to encompass the current situation of the underwater places where dolphins and manatees live. Students expand their idea of habitat when they figure out that habitats help animals survive, and that changes to those habitats, such as from human interactions, can affect the plants and animals living there.
K.4 → 2.4	***PEs**: K-LS1-1, 2-LS2-1* ***LS1.C Organization for Matter and Energy Flow in Organisms** Plants need water and light to live and grow. [K.4]* ***LS2.A Interdependent Relationships in Ecosystems** Plants depend on water and light to grow. [2.4]*
	Progression of Ideas: Needs of plants **In Unit K.4**, students figure out that animals and plants get what they need from the environments they live in. They rely on prior experiences with plants as well as Plant Need cards (similar to plant tags) and a book about plants growing in different communities to figure out a pattern: wherever they live, plants get the light and water they need. **In Unit 2.4**, students build on their prior experiences (from Unit K.4 and outside science class) to collaboratively design a multi-lesson investigation to gather evidence that plants need light and water to grow and stay healthy.
1.4 → 2.4	***PEs:** 1-LS1-1, 2-LS2-2* ***Structure and Function** All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. [1.4]* ***LS2.A Interdependent Relationships in Ecosystems** Plants depend on animals for pollination or to move their seeds around. [2.4]*
	Progression of ideas: How plant and animal parts help get seeds moved to new locations

Units	Progression of DCIs in Life Sciences Across Units
	In Unit 1.4, students investigate plant and animal parts, including fruits and flowers, as well as beaks, legs, mouths, paws, coverings (e.g., skin, fur, scales), and wings. **In Unit 2.4**, when students consider how seeds can be moved, they recall what they figured out about animals' parts used for eating things like seeds. They use what they know about animal coverings to figure out that some seeds might stick to and be carried on an animal, and they use what they know about animal wings to notice that wing-like parts of seeds help them to be carried by the wind.
1.4 → 4.4	***PEs:*** *1-LS1-1, 4-LS1-1, 4-LS1-2* ***LS1.A Structure and Function*** *All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. [1.4]* ***LS1.D Information Processing*** *Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. [1.4]* ***LS1.A Structure and Function*** *Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. [4.4]* ***LS1.D Information Processing*** *Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. [4.4]*
	Progression of ideas: How animals use their parts for sensing and survival **In Unit 1.4**, students gather information about how animals use their external parts to detect food, danger, and signals from their offspring. They also observe how young animals use sounds and movements to communicate needs to parents, and how parents use their senses to detect and respond to those signals with behaviors that help their young survive. Students also investigate how plants' external parts help them survive. **In Unit 4.4**, students move right on past plants' external parts and investigate the internal parts plants use to help them survive and grow. Also in Unit 4.4, students build on ideas about body parts that capture information, assuming students already know about external parts like noses and ears, so they can move on to explore the sense receptors animals have and how they process information from sense receptors in the brain to be able to do things like escape predators and care for young.
2.3 → 3.3 → 4.3	***PEs:*** *2-LS4-1, 3-LS4-1, 4-ESS1-1* ***LS4.D Biodiversity and Humans*** *There are many different kinds of living things in any area, and they exist in different places on land and in water. [2.3]* ***LS4.A Evidence of Common Ancestry and Diversity*** *Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. [3.3]* ***ESS1.C The History of Planet Earth*** *Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. [4.3]*

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Units	Progression of DCIs in Life Sciences Across Units
	Progression of ideas: How we can make sense of fossils **In Unit 2.3**, students investigate national parks to figure out that many different kinds of plants and animals live in different land and in water habitats. **In Unit 3.3**, students use an infographic, data cards, gallery tours, and a book to investigate what fossils are. They use ideas from Unit 2.3 to interpret data from fossils as evidence of what the environment of that area may have been like long ago (e.g., fossils of fish and other marine life indicate a water habitat when those plants and animals lived there, even if it is not underwater today). **In Unit 4.3**, students investigate land changing over time and read an article about fossils uncovered in several national parks. Students draw on ideas of fossils as evidence of environments long ago to investigate patterns in the national parks' fossils and figure out what fossils reveal about changes to a landscape over time.
2.4 → 3.2 → 3.3	***PEs:*** *2-LS2-2, 3-LS1-1* ***LS2.A Interdependent Relationships in Ecosystems*** *Plants depend on animals for pollination or to move their seeds around. [2.4]* ***LS1.B Growth and Development of Organisms*** *Reproduction is essential to the continued existence of every kind of organism. Plants [3.2] and animals [3.3] have unique and diverse life cycles.*
	Progression of ideas: Plant and animal life cycles **In Unit 2.4**, students figure out important plant parts: seeds (grow new plants), flowers (have pollen that is needed to make seeds), and fruits (hold seeds and animals eat them). **In Unit 3.2**, students use these ideas when they are figuring out how we get fruits all year. The class has an initial ideas discussion to surface what they already know about how fruits and vegetables grow, leading to what they will figure out in that unit about plant life cycles. **In Unit 3.3**, students wonder how canines can look so similar as puppies but so different as adults. They investigate how canines (and then other animals) grow and develop over time, following life cycles with similar stages. Students discover that one of those stages is adulthood, at which time animals can reproduce. Teachers are guided to help students make comparisons between plant life cycles (from Unit 3.2) and animal life cycles in this unit to build students' understanding of this idea.
3.3 → 3.4	***PE:*** *3-LS3-1* ***LS3.A Inheritance of Traits*** *Many characteristics of organisms (the PE specifies plants [3.4] and animals [3.3]) are inherited from their parents.*
	Progression of ideas: Plants and animals inherit trait variations from their parents **In Unit 3.3**, students investigate canines and other animals to figure out that animals inherit trait variations, such as fur color or fetching behavior, from their parents. **In Unit 3.4**, students investigate whether their ideas about animal trait variations and inheritance also apply to plants, which can be more difficult to observe. They investigate trait variations in seagrasses (such as leaf width or ability to survive in freshwater) and use evidence from their observations and other data to explain that plants, like animals, also inherit trait variations from their parents.

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Units	Progression of DCIs in Life Sciences Across Units
	Students can more easily observe trait variations and make sense of inheritance patterns in animals than in plants, so they address this idea with animals in Unit 3.3 first, before plants in 3.4.

Table A.2 Building DCI Connections in Physical Sciences

Units	Progression of DCIs in Physical Sciences Across Units
K.3 → 3.1 → 4.1 → 4.2 → 5.1	***PEs:*** *K-PS2-1, K-PS2-2, 3-PS2-1, 3-PS2-2, 4-PS3-2, 4-PS3-3, 5-PS3-1* ***PS2.A Forces and Motion*** *Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. [K.3]* ***PS3.C Relationship Between Energy and Forces*** *A bigger push or pull makes things speed up or slow down more quickly. [K.3]* ***PS2.A Forces and Motion*** *Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. [3.1]* ***PS2.A Forces and Motion*** *The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. [3.1]* ***PS3.A Definitions of Energy*** *Energy can be moved from place to place by moving objects [4.1 and 4.2] or through sound [4.1 and 4.2], light [4.2], or electric currents [4.2].* ***PS3.B Conservation of Energy and Energy Transfer*** *Energy is present whenever there are moving objects, sound, light [4.2], or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. [4.1]* ***PS3.C Relationship Between Energy and Forces*** *When objects collide, the contact forces transfer energy so as to change the objects' motions. [4.1]* ***LS1.C Organization for Matter and Energy Flow in Organisms*** *Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. [5.1]* ***PS3.D Energy in Chemical Processes and Everyday Life*** *The energy released [from] food was once energy from the Sun that was captured by plants in the chemical process that forms plant matter (from air and water). [5.1]*
	Progression of ideas: How forces are related to changes in motion and energy transfer **In Unit K.3**, students use toy cars and ping pong balls to explore pushes and pulls, figuring out that strength, direction, and speed are descriptors of forces and motion. They also investigate collisions, and figure out that when objects touch or collide, they push on one another and this force changes motion and direction. **In Unit 3.1,** students build on these ideas by considering multiple forces acting on an object at one time. While the forces can still be described as pushes and pulls, third grade students take this idea further by building sculptures to explore situations when the forces on an object are balanced or unbalanced. They also figure out that forces can exist without anything touching (e.g., magnets).

Units	Progression of DCIs in Physical Sciences Across Units
	In Unit 4.1, students apply these ideas to explain collisions as contact forces that transfer energy to change an object's motion, such as why a kick gets a soccer ball moving. There are opportunities early in Unit 4.1 to (re)teach ideas about forces from third grade, if needed; students build upon the idea of contact forces quickly and often as they investigate collisions and sense of how they transfer energy. In Unit 4.1, students figure out that energy can be transferred through collisions, sound, and heat, and that sound, heat, and changes in motion are evidence of energy transfer. (These energy transfer cases are easier to observe and make sense of in investigations than what follows in Unit 4.2.) **In Unit 4.2**, students build on what they figured out in Unit 4.1 to make sense of the more complex energy transfer cases of electricity and light as they explore. how clocks and other electrical devices work. They use ideas from Unit 4.1 about sound, heat, and changes in motion as evidence of energy transfer to help them investigate how energy can also be transferred through light and electric currents. They continue to use changes in motion as evidence of energy transfer in the new contexts of how solar panels make a motor spin and how water and wind turn turbines to generate electricity. **In Unit 5.1**, students begin to explore energy transfer in a life sciences context, figuring out that energy in animals' food was once energy from the Sun, captured by plants, and that animals use energy transferred from food to move and regulate their body temperatures. Students can use ideas about energy transfer they developed in a physical sciences context in fourth grade to make sense of how energy is transferred between organisms and their environment.
1.1 → 4.4	***PEs:*** *1-PS4-2, 1-PS4-3, 4-PS4-2* ***PS4.B Electromagnetic Radiation*** *Objects can be seen if light is available to illuminate them or if they give off their own light. [1.1]* ***PS4.B Electromagnetic Radiation*** *Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. [1.1]* ***PS4.B Electromagnetic Radiation*** *An object can be seen when light reflected from its surface enters the eyes. [4.4]*
	Progression of ideas: Animals need light to see **In Unit 1.1**, students investigate how they can read under covers (or not) to build ideas about how light shines through and reflects off of different materials, and that objects can be seen if there is enough light available to illuminate them. **In Unit 4.4**, students investigate how flying squirrels and other animals use specific body parts (like eyes) to sense the world around them (e.g., find food) to survive, they use this idea that light "bounces off" the food to explain how squirrels can see their food.
1.2 → 4.1	***PEs:*** *1-PS4-1, 4-PS3-2, 4-PS3-3* ***PS4.A Wave Properties*** *Sound can make matter vibrate, and vibrating matter can make sound. [1.2]* ***PS3.B Conservation of Energy and Energy Transfer*** *Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. [4.1]*

Units	Progression of DCIs in Physical Sciences Across Units
	Progression of ideas: How sound/vibrations are related to energy transfer **In Unit 1.2**, students explore several types of musical instruments to figure out that vibrating things can make sound, and that sound can also make things vibrate (small, fast, repetitive movement back and forth). They observe that drums vibrate and make noise when they are hit, and things nearby the drum can also move when that noise happens. **In Unit 4.1**, students revisit this idea of vibration when they investigate a kick drum being hit with a pedal. They notice the drum vibrates more with a harder kick/hit, which causes a louder sound, and explain that louder sounds occur because more energy is being transferred. They also gather additional evidence of this connection between more energy, more sound, and more vibration when they observe the effects of loud drumming on objects nearby. Students figure out that sound is both evidence of energy transfer and a way in which energy can be transferred.
1.2 → 4.2	***PEs:*** *1-PS4-4, 4-PS4-3* ***PS4.C Information Technologies and Instrumentation*** *People use a variety of devices to communicate (send and receive information) over long distances. [1.2]* ***PS4.C Information Technologies and Instrumentation*** *Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. [4.2]*
	Progression of ideas: How people communicate over distances **In Unit 1.2**, students investigate how people communicate messages over distances using sound, such as with clocktower bells, sports whistles, and traffic horns. They design a signal instrument of their own to communicate a "good news" message across the classroom. **In Unit 4.2**, students build on these ideas about transmitting information across a distance when they investigate how some devices, like clocks and phones, can always know the correct time without being set. They figure out that digital information is made of "on" and "off" patterns and can be transferred using light signals that humans cannot see. Students design another way to communicate a message across a distance, this time using light to transmit digitized information.
3.1 → 5.3	***PEs:*** *3-PS2-1, 5-PS2-1* ***PS2.A Forces and Motion*** *Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. [3.1]* ***PS2.B Types of Interactions*** *The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. [5.3]*
	Progression of ideas: Gravity pulls objects down **In Unit 3.1**, when students investigate the balanced and unbalanced forces that keep their sculptures standing up, they begin to define gravity as a force that pulls objects downward—and helps explain why their unbalanced sculptures fall down.

Units	Progression of DCIs in Physical Sciences Across Units
	In Unit 5.3, when students work to make sense of how gravity acts on things (like water) moving down a slope, they connect to their ideas about gravity pulling downward from Unit 3.1. Students use and expand on these ideas to help them explain how a river can flow from south to north.
5.1 → 5.2	***PE:*** *5-PS1-1* ***PS1.A Structure and Properties of Matter*** *Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. [5.1, 5.2]*
	Progression of ideas: Matter is made of particles that are too small to see **In Unit 5.1**, students try to figure out where plants get the matter they use to grow, so they weigh water, air (inside a ball), and light. Since their data indicate air has weight, they propose that air is made up of matter that is too small to see. To confirm that air is made of these tiny particles, students also test the behavior of a syringe with air trapped in it. They are able to model the behavior of air as particles that spread out in the ball they weighed and the syringe (getting squished and spreading back out). These foundational investigations help students gather direct evidence that matter can be present even if we cannot see it. **In Unit 5.2**, students build on what they figured out from their investigations of air in Unit 5.1 to help them make sense of a more complicated phenomenon. They try to filter water to make it cleaner and healthier, but they notice the water samples (mixtures) they already filtered still have unusual colors and odors. Drawing on the ideas from Unit 5.1, they propose that the colors and/or odors come from particles too small to see (individually) mixed into the water. After reading about some related phenomena, students use boiling and solar stills to further separate the matter in their water samples. They use models to explain that they contain particles too small to see (individually), some of which have properties that keep them in the pot or bowl when water particles leave into the air.

Table A.3 Building DCI Connections in Earth and Space Sciences

Units	Progression of DCIs in Earth and Space Sciences Across Units
K.2 → 3.2 → 4.3	***PEs:*** *K-ESS2-1, K-ESS3-2, 3-ESS3-1, 4-ESS3-2* ***ESS2.D Weather and Climate*** *Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. [K.2]* ***ESS3.B Natural Hazards*** *Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. [K.2]* ***ESS2.D Weather and Climate*** *Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. [3.2]*

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Units	Progression of DCIs in Earth and Space Sciences Across Units
	ESS3.B Natural Hazards *A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. [3.2, 4.3]*
	Progression of ideas: Typical and hazardous weather **In Unit K.2**, students observe weather conditions (e.g., cloudiness, air temperature, wind speed, and precipitation) and investigate how to prepare for those conditions, including in severe weather that happens in their locality. **In Unit 3.2**, students build on these ideas about weather as they find patterns in weather around the world to figure out ideas about climate, and as they investigate a variety of weather hazards that can damage crops. Students go further in making sense of severe weather preparation when they engineer design solutions to reduce the impact of wind on fruit trees. **In Unit 4.3**, students investigate damage to a road by an unknown natural hazard, so they leverage ideas from Unit 3.2 to guide them, considering wind as a cause of damage. Students figure out that a storm damaged the road, but that waves caused the most significant damage. Students then research and engineer solutions for reducing the effects of weathering and erosion by water.
1.3 → 5.4	***PEs:*** *1-ESS1-1, 5-ESS1-2* ***ESS1.A The Universe and Its Stars*** *Patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted. [1.3]* ***ESS1.B Earth and the Solar System*** *The orbits of Earth around the Sun and of the Moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the Sun, Moon, and stars at different times of the day, month, and year. [5.4]*
	Progression of ideas: Patterns in the sky **In Unit 1.3**, students identify the "low, high, low" pattern of the Sun's and Moon's apparent motion in the sky. Students also establish that the Sun is only visible in the sky in the daytime and the stars are only visible in the sky at night. Students figure out that the Moon cannot be used as evidence for day or night since it sometimes appears in the daytime sky and sometimes in the nighttime sky. **In Unit 5.4**, students revisit these prior observations and are motivated to figure out why those patterns occur. They use various types of models to figure out the Earth's rotation and describe the Moon's orbit around the Earth, and use their models to explain these patterns.
2.1 → 4.3 → 5.3	***PEs:*** *2-ESS1-1, 2-ESS2-1, 4-ESS1-1, 4-ESS2-1, 5-ESS2-1* ***ESS1.C The History of Planet Earth*** *Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. [2.1]* ***ESS2.A Earth Materials and Systems*** *Wind and water can change the shape of the land. [2.1]* ***ESS1.C The History of Planet Earth*** *Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. [4.3]*

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Units	Progression of DCIs in Earth and Space Sciences Across Units
	ESS2.A Earth Materials and Systems *Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. [4.3]* ***ESS2.A Earth Materials and Systems*** *Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. [5.3]*
	Progression of ideas: Land changes over time **In Unit 2.1**, students explore land changes in their community to figure out how changes to Earth's surface are caused by wind and water over different periods of time. They also engineer design solutions to slow changes to land by wind or water. **In Unit 4.3**, students investigate changes to land in various national parks, and also consider how to reduce the effects of weathering and erosion. When students brainstorm ideas for design solutions, they bring ideas about what worked (or not) from their experiences in Unit 2.1 to support them. **In Unit 5.3**, students build on their ideas about how water changes land to plan an investigation of how damming a river could affect its environment. Students draw on these ideas to predict how pouring water will affect the dirt and clay in their river model. They predict how a dam might impact the river and sediment based on their designs in Unit 4.3 to reduce effects of weathering and erosion.
2.2 → 2.3	***PEs:*** *2-PS1-1, 2-ESS2-3* ***PS1.A Structure and Properties of Matter*** *Different kinds of matter exist, and many of them can be either solid or liquid, depending on temperature [2.3]. Matter can be described and classified by its observable properties [2.2].* ***ESS2.C The Roles of Water in Earth's Surface Processes*** *Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form [2.3].*
	Progression of ideas: Matter as solids and liquids **In Unit 2.2**, students investigate the properties different toy-making materials have and apply what they figured out about observable properties to engineer their own toy designs. Students investigate reversible and irreversible changes, such as melting, and they figure out that matter (such as wax) can be either solid or liquid. **In Unit 2.3**, students figure out where plants and animals live, including in (liquid) water and on or around solid ice, and investigate the role temperature plays in determining those states of matter.

Table A.4 Building DCI Connections in Engineering, Technology, and Applications of Science

Units	Progression of DCIs in Engineering, Technology, and Applications of Science Across Units
K.1→ K.3→ 1.2→ 1.4→ 2.1→ 2.2	***PE:*** *K-2-ETS1-1* ***ETS1.A Defining and Delimiting Engineering Problems*** • *A situation that people want to change or create can be approached as a problem to be solved through engineering.* • *Asking questions, making observations, and gathering information are helpful in thinking about problems.* • *Before beginning to design a solution, it is important to clearly understand the problem.*
	Progression of ideas: Defining engineering problems **In kindergarten,** Units K.1 and K.3 each support students in working with the idea that engineering uses math, science, and creativity to solve problems. Each unit uses a variety of texts to introduce and reinforce the idea that engineers talk with people to understand their needs and desires involved in identifying problems. Students make observations (of their schoolyard and of existing games and interactions of different objects) to gather ideas about what their design solutions need to do to work well, and they explore available materials to inform potential solutions. The whole class works together to define the engineering problems defined locally for their school. **In first grade,** students dig deeper into the idea of asking questions and gathering information to help solve problems from books describing how an engineer works with the DeafBlind community to design communication devices and how a neuroengineer studies octopuses to design better prosthetic limbs for people. In Unit 1.2, the class solves the same problem; in Unit 1.4, each student designs a solution for multiple human problems that could be solved using ideas from plant or animal parts. Some of these are community problems that go beyond the classroom or school. **In second grade,** students engage with more complex problems. In Unit 2.1, the class works together to define a problem related to land moving that is local to their own community (in their schoolyard or beyond), and they gather information about existing solutions used by other communities to inform their work. Unit 2.2 provides a kind of culminating experience for defining problems when students interview kindergartners to determine what kinds of toys would be most interesting and enjoyable to them, and design toys for them based on what they learn.
	PE: *K-2-ETS1-2* ***ETS1.B Developing Possible Solutions*** *Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.*

K.1→ K.3→
1.2→ 1.4→
2.1→ 2.2

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Units	Progression of DCIs in Engineering, Technology, and Applications of Science Across Units
	Progression of ideas: Drawings and physical models help us communicate about designs **In kindergarten,** students share design ideas with partners for keeping the blacktop less hot [K.1] and for creating a maze-like game [K.3]. They make design decisions before building physical designs used for testing their ideas. They read about examples of how engineers and other experts convey their design ideas. Finally, they use drawings of their designs to reflect on what worked to keep the blacktop less hot or achieve the goals of the game and why. They explain how their designs use science ideas they figured out about sunlight heating Earth's surface and how objects can change motion when they collide , and share those ideas with teachers and classmates. **In first grade,** students use drawings to communicate ideas about their designs in order to get feedback from peers to inform decisions before building their solutions. In kindergarten, most designs generated by students in the class are quite similar; in first grade, the designs generated by pairs of students have more variety. For example, when communicating a good news message across the classroom [1.2], students create many different types of instruments and noise-makers. When trying to solve human problems about protection, movement, or getting food [1.4], students design solutions inspired by plant or animal parts. Students explore how their physical models can help communicate their solutions to others in their classroom. **In second grade,** Unit 2.1 provides an opportunity for students to draw and use physical models to communicate about design solutions for their community-based land moving problem, which is larger-scale and more complex than many of the problems students developed solutions for in earlier grades. Therefore, the class works together throughout the unit to discuss improvements to the physical models they use for testing. Unit 2.2 offers students a chance to communicate about their design solutions with an audience other than their peers when they use drawings and built designs to share toy designs with the kindergartners they designed them for.
K.3 → 1.2 → 2.1	***PE:*** *K-2-ETS1-3* ***ETS1.C Optimizing the Design Solution*** *Because there is always more than one possible solution to a problem, it is useful to compare and test designs.*
	Progression of ideas: Comparing design solutions helps improve our designs **In Unit K.3,** students engage in several cycles of testing and comparing game board designs. Then they compare and discuss final designs to recognize that multiple solutions can be successful in reaching the same goal. **In Unit 1.2,** students do formal and informal tests of their sound signal device designs to gather evidence of how well they work. Students compare designs through discussions and gallery tours, reinforcing the idea that engineering problems may have multiple solutions. **In Unit 2.1,** students compare existing solutions for preventing or slowing changes to land from their families/communities and texts they read to help them identify useful shapes and structures for their own designs, considering multiple possible solutions to their problem. Student teams develop and compare design solutions before testing their effectiveness. Students discuss strengths and weaknesses of their different design solutions and try to determine which design would best solve a problem of land moving in their community (e.g., mulch leaving the playground area, soil

Units	Progression of DCIs in Engineering, Technology, and Applications of Science Across Units
	being washed out of garden beds), which sets them up for success in how they will try to optimize designs in grades 3-5.
3.1 → 4.2 → 5.2	***PE:*** *3-5-ETS1-1* ***ETS1.A Defining and Delimiting Engineering Problems*** *Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.*
	Progression of ideas: Criteria and constraints help us compare design solutions **In Unit 3.1,** students track ideas throughout the unit about what their sculptures need to do to be successful and how their designs are limited. Students identify these ideas as "criteria and constraints" that must be met in their designs. Students reflect on their progress of problems and solutions and formally define "criteria and constraints." **In Unit 4.2,** students design, test, and refine devices for communicating the time to help them figure out how information can be transferred to devices like clocks. Students work as a class to brainstorm and identify their criteria for success and the constraints they need to follow. They then use test data in small groups to evaluate their design solutions based on those criteria and constraints. **In Unit 5.2**, students have another opportunity to define a problem using criteria and constraints as they design water filters, and compare different filter designs in terms of those criteria and constraints to determine which best removes unhealthy materials from water. Students then work individually to propose criteria and constraints for one of two different community water problems.
3.1→ 4.2 → 5.2	***PE:*** *3-5-ETS1-3* ***ETS1.B Developing Possible Solutions*** *Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.* ***ETS1.C Optimizing the Design Solution*** *Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.*
	Progression of ideas: Testing design solutions helps improve them **In Unit 3.1,** students run tests of different sculpture designs, recording what worked and did not work in their designs, and discuss these difficulties with small groups and the class. Students design multiple iterations of sculptures, informed by their testing and tinkering and to best meet the descriptions on their list of criteria and constraints. **In Unit 4.2,** students work in small groups to design devices to communicate the time. The class collaboratively plans a formal fair test investigation to identify failure points in their designs. Students engage in peer feedback and a class discussion to compare and contrast their solutions based on their class criteria and constraints, determining which solutions best solve the problem. Students have an opportunity to improve their designs based on their test data. **In Unit 5.2,** students work in small groups to figure out that focused testing of their water filters over multiple rounds of redesign allows them to identify challenges, know which solutions best meet the

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Units	Progression of DCIs in Engineering, Technology, and Applications of Science Across Units
	criteria and constraints, and inform design improvements. Students then use peer feedback and class-developed criteria and constraints to optimize designs that solve a community water problem.
3.2 → 4.3 → 5.3	***PE:*** *3-5-ETS1-2* ***ETS1.B: Developing Possible Solutions*** • *Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.* • *At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.*
	Progression of ideas: Research, testing, and communication are important when designing solutions **In Unit 3.2,** students work as a class to research hazardous weather to figure out how it affects fruit plants, then use that information to develop models to explain how their own windbreak designs will protect fruit plants. Students work in small groups to build and test their windbreaks under low and high wind conditions and communicate with other students to compare the outcomes. **In Unit 4.3,** students research places that have experienced erosion damage similar to what they observe on a road in a national park, and then develop and compare initial designs for reducing the effects of waves on that road. Students generate different sizes of waves to test their designs under a variety of conditions and communicate with classmates about what works. Students then use research and test data to inform their individual designs to reduce erosion in a national park. **In Unit 5.3,** students choose a community water problem from a menu of three and work with their classmates to compare and contrast possible solutions. They research for their chosen scenario where water in the community comes from and how people in that area use water. After students synthesize this information with classmates, they brainstorm initial design solution ideas individually and with partners, then work with small groups to obtain information about additional potential solutions. The class works together to develop a list of testing considerations, and students work in pairs to compare solutions and give and receive feedback about them. They use their feedback to optimize their plan for improving the water problem in their scenario. Finally, students have an individual opportunity to research a different community's water problem, generate a design solution, and compare it to other possible solutions.

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Opportunities for additional DCI connections across units

The previous section, Tables A.1 through A.4, reflecting the connections shown in Figure 1, explains those connections needed to build the DCIs to address the performance expectations in NGSS. There are other additional connections that might occur to your students, or that you may choose to highlight if helpful. These connections differ from the prior section in that we do not view these as essential to students' sensemaking and meeting the NGSS performance expectations.

For simplicity, we call these connections "optional" or non-essential. There are several kinds of connections in this group.

- For example, students might bring in ideas from earlier units that are related to the current problem-solving context in some way, but are not essential to building the parts of the disciplinary core ideas targeted in NGSS.
    - For example, students could potentially connect ideas that light sources make it easier to see (Unit 1.1) to patterns of daytime and nighttime in Unit 1.3, but this is not part of the PEs for first grade.
- In some cases, while students might bring in ideas from units several grades before that could potentially be helpful, there is sufficient emphasis and support for building those ideas within the current unit. Thus while we encourage teachers to honor those connections if they arise and bring them into the discussion, it is not essential to do so, and the work of the current unit is enough by itself.
    - For example, students could potentially bring into third grade Units 3.2 and 3.3 the idea from Unit 1.4 that young animals and plants have both similarities and differences to parents. While helpful to do so, the question of why there are both similarities and variation is raised explicitly and supported as a focus of the third grade units, and so this connection is not essential.
- Students might bring in ideas from earlier units that could (eventually) be connected to what they are figuring out in the current unit, but making those connections in depth would be beyond the expectations of the current grade.
    - For example, students might connect what they figure out about sunlight warming Earth's surfaces (Unit K.1) with weather conditions (Unit K.2), but kindergarten students have not yet developed the other science ideas needed to explain how sunlight influences air temperature. They build those ideas in later grades, so we do not recommend that teachers bring up this connection.

In these situations, while not essential to meeting the performance expectations, teachers should honor their students' ideas and acknowledge these connections if they arise from students. If students raise these ideas from a prior unit, teachers can prompt them to explain how the ideas connect or how that helps them figure out their current questions. However, we do not recommend that teachers introduce these connections themselves.

For this reason, while not depicted in Figure 1, these potential connections are mentioned in each unit's front matter, and often noted in sidebar callouts in the teacher guides. We summarize these connections here in Table B.

Table B Optional DCI Connections

Units	Optional DCI Connections to Prior Units
K.1→ K.2	***PEs:*** *K-PS3-1, K-PS3-2, K-ESS2-1* ***PS3.B Conservation of Energy and Energy Transfer*** *Sunlight warms Earth's surface. [K.1]* ***ESS2.D Weather and Climate*** *Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. [K.2]* **Optional connections:** If students work on Unit K.1 before Unit K.2, students might connect what they figured out about sunlight warming Earth's surfaces in Unit K.1 with weather conditions they observe in Unit K.2. However, students at this grade level are not expected to make sense of how sunlight influences air temperature, so we recommend that teachers do not bring up this connection. Teacher guidance is provided to support and unpack this potential connection if students raise it (e.g., considering whether it always feels warm outside on sunny days).
K.1 → 4.2	***PEs:*** *K-PS3-1, K-PS3-2, 4-PS3-2* ***PS3.B Conservation of Energy and Energy Transfer*** *Sunlight warms Earth's surface. [K.1]* ***PS3.B Conservation of Energy and Energy Transfer*** *Light also transfers energy from place to place. [4.2]* **Optional connections:** In Unit K.1, students develop ideas about sunny areas being warm and shady areas being less warm. Students also have ideas from outside-school experiences about sunnier spaces and times being warmer. Students might use this idea of sunlight warming things in Unit 4.2 when discussing whether light is evidence of energy transfer, or when they investigate whether energy from light can be transferred to electric currents in Unit 4.2. However, students are not expected at this grade level to make sense of how much energy is transferred or how heat and light are related in terms of energy transfer, so this connection is not expected.
K.2 → 2.1	***PEs:*** *K-ESS2-1,2-ESS2-1* ***ESS2.D Weather and Climate*** *Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. [K.2]* ***ESS2.A Earth Materials and Systems*** *Wind and water can change the shape of the land. [2.1]*

Units	Optional DCI Connections to Prior Units
	Optional connections: As students in Unit 2.1 explore how rain and wind affect land, students might connect to weather ideas they figured out in Unit K.2 or from their outside-school experiences, such as how wind blows with different strengths, or that varied amounts of water can fall from the sky when it rains, or that cloudy skies do not always mean rain will happen. At second grade, students are not expected to compare intensities of weather and the related effects. If students bring up these ideas, honor their questions and ideas, but you do not need to raise them.
K.4 and 2.4 → 5.1	***PEs:*** *K-LS1-1, 2-LS2-1, 5-LS1-1, 5-PS3-1* ***LS1.C Organization for Matter and Energy Flow in Organisms*** *All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. [K.4]* ***LS2.A Interdependent Relationships in Ecosystems*** *Plants depend on water and light to grow. [2.4]* ***LS1.C Organization for Matter and Energy Flow in Organisms*** *Plants acquire their material for growth chiefly from air and water. [5.1]* ***PS3.D Energy in Chemical Processes and Everyday Life*** *The energy released from food was once energy from the Sun that was captured by plants in the chemical process that forms plant matter (from air and water). [5.1]* **Optional connections:** In Units K.4 and 2.4, students gather evidence that plants need sunlight and water to grow. They build on those ideas in Unit 5.1 when they figure out that sunlight is important because plants use energy from the Sun along with matter from water and air to grow. However, if students did not know upon starting Unit 5.1 that plants need sunlight and water to grow, the data they explore in Unit 5.1 will support them in figuring out that idea as well.
1.1 → 1.3	***PEs:*** *1-PS4-2, 1-ESS1-2* ***PS4.B Electromagnetic Radiation*** *Objects can be seen if light is available to illuminate them or if they give off their own light. [1.1]* ***ESS1.B Earth and the Solar System*** *Seasonal patterns of sunrise and sunset can be observed, described, and predicted. [1.3]* **Optional connections:** In their work in Unit 1.1, students figure out that light sources make spaces brighter so things are easier to see. When students figure out in Unit 1.3 that the Sun is out during the daytime, they might connect to the Sun as a light source that causes it to be brighter during the daytime. The term "light source" is not specifically used in Unit 1.3, and students do not need to explain that things are easier to see in the daytime because the Sun is shining to make sense of the ideas they build in Unit 1.3 or to meet the first grade PEs.
1.4 → 3.2 → 3.3 → 3.4	***PEs:*** *1-LS1-2, 1-LS3-1, 3-LS1-1, 3-LS3-1* ***LS1.B Growth and Development of Organisms*** *Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. [1.4]* ***LS3.A Inheritance of Traits*** *Young animals are very much, but not exactly, like, their parents. Plants also are very much, but not exactly, like their parents. [1.4]*

Units	Optional DCI Connections to Prior Units
	LS1.B Growth and Development of Organisms *Reproduction is essential to the continued existence of every kind of organism. Plants [3.2] and animals [3.3] have unique and diverse life cycles.* ***LS3.A Inheritance of Traits*** *Many characteristics of organisms are inherited from their parents. [3.3, 3.4]* **Optional connections:** In Unit 1.4, students investigate several different examples of adults and offspring to help them figure out that plants and animals can have young and that sometimes animal parents and/or young engage in behaviors to help the young survive. Students can build on these ideas when they make sense of life cycles of plants in Unit 3.2 and canines and other animals in Unit 3.3, but they are not essential because they investigate many additional examples of adults and offspring in the third grade units. In addition, in Unit 1.4, students construct evidence-based claims supported by observations that young animals and plants are very much, but not exactly, like their parents, and that individuals of the same kind of plant or animal are similar but can vary. Students have multiple additional opportunities to investigate examples of young that look like but not exactly like their parents in Unit 3.3 (animals) and Unit 3.4 (plants) as they figure out that inherited information is the cause of these patterns. Students may also bring these ideas about parents and young to third grade from their own outside-school experiences.
2.3 → 4.3	***PEs:*** *2-ESS2-2,4-ESS2-2* ***ESS2.B Plate Tectonics and Large-Scale System Interactions*** *Maps show where things are located. One can map the shapes and kinds of land and water in any area. [2.3]* ***ESS2.B Plate Tectonics and Large-Scale System Interactions*** *The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth. [4.3]* **Optional connections:** When students use maps in Unit 4.3 to figure out patterns in features of Earth's surface (above and below the oceans), they may recall their foundational work with maps in Unit 2.3. In Unit 2.3, students use multiple kinds of maps showing where land and water is located within an area of a national park, and figure out that maps are representations that show where things are located in the real world. While helpful to make this connection if it comes up, there is sufficient support in Unit 4.3 to build the idea when students are using more complex maps in the unit, and support for students to bring in other experiences with maps from outside of science classes, as well.
5.2 → 5.3	***PEs:*** *5-PS1-3, 5-PS1-4, 3-5-ETS1-1, 5-ESS3-1* ***PS1.A Structure and Properties of Matter*** *Measurements of a variety of properties can be used to identify materials. [5.2]* ***PS1.B Chemical Reactions*** *When two or more different substances are mixed, a new substance with different properties may be formed. [5.2]* ***ETS1.A Defining Engineering Problems*** *Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of*

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Units	Optional DCI Connections to Prior Units
	how well each one meets the specified criteria for success or how well each takes the constraints into account. [5.2] ***ESS3.C Human Impacts on Earth Systems*** *Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. [5.3]* **Optional connections:** In Unit 5.2, students explore properties of matter in the context of healthy and unhealthy water, and they design filters and other solutions for community clean water problems. In Unit 5.3, students investigate how human activities, such as damming rivers, affect Earth's spheres, and how people are working to help protect Earth's resources. Students in Unit 5.3 also engineer solutions for community water access problems. So, students may connect ideas between these two units about the role water plays in natural systems and how humans impact water resources, especially as they consider potential solutions for solving water problems. However, students are able to completely make sense of the ideas in each unit and accomplish the PEs without these connections.

Appendix B: How OpenSciEd Units Support the Progressions of SEPs and CCCs

This Appendix expands on the definitions from Tables 1.A, 1.B, and 1.C to identify the particular criteria for classifying how a unit treats an SEP or CCC. This appendix explains what supports are available in each unit that intentionality develops SEPs or CCCs, and how students use SEPs and CCCs in units that provide opportunities to practice them.

To track how OpenSciEd helps students build the SEPs and CCCs, it is important to note that the performance expectations in NGSS are written in terms of elements or individual parts of the DCI, SEP, and CCC. The collection of elements together define a particular SEP or CCC or DCI. For example, the SEP Analyzing and Interpreting Data (abbreviated DATA in Appendix C) is defined by the combination of five elements at the K-2 gradeband, including "Record information (observations, thoughts, and ideas)" [DATA-P1]; "Use and share pictures, drawings, and/or writings of observations" [DATA-P2]; and "Compare predictions (based on prior experiences) to what occurred (observable events)" [DATA-P4]. In the explanation of how we support progressions, we will refer to particular elements of the SEP and CCC to align with NGSS. (Appendices C and D contain the full list of SEP and CCC elements for K-2 and 3-5.)

The Unit Intentionally Develops the SEP or CCC

The following reasons explain why a unit intentionally develops a particular SEP or CCC.

A. SEPs and CCCs that are tied to performance expectations (PEs) in the unit bundle are typically Intentionally Developed in the unit.
    - When a unit's bundle includes more than three different SEPs connected to its PEs, we occasionally made intentional decisions about whether to skip intentionally developing one or more of them because limited instructional time during a school year does not allow for truly developing so many SEPs in one unit.
    - In those cases, the SEPs that are not intentionally developed are treated as opportunities to practice in that unit, and are intentionally developed in one or more other units in that grade level.

B. A goal when developing this program was to intentionally develop all SEPs at least once per grade level and all CCCs at least once per grade band.
    - We did not "force" intentionally developing SEPs and CCCs into units if doing so would not make sense for the work students were doing (e.g., progressing through multiple opportunities, including it in assessments). As such,

- Grade 1 only has opportunities to practice Asking Questions and Defining Problems.
- Grade 2 only has an opportunity to practice Using Mathematics and Computational Thinking.

There are several characteristics that support intentional development of an SEP or CCC. These have in common that students need to extend or broaden their current ideas and ways of using an SEP or CCC to do the work of the current unit. That is, the unit contains tasks and supports for something students need to learn about the SEP or CCC.

Why is this important? The Intentionally Developed categorization indicates SEPs and CCCs to attend to if skipping or reordering OpenSciEd units. If a unit that intentionally develops an SEP or CCC is skipped, students will miss something important about the SEP or CCC that later-grade work may rely on. Consequently, it would be necessary to address those aspects of the SEP or CCC in some other way.

A unit that intentionally develops a particular SEP or CCC typically includes several of the following characteristics.

1. **Explicitly introduces the SEP or CCC to students, guided by the elements at that grade band.** As students use an SEP or CCC in the work of a unit, class discussion includes identifying the practice or concept, why it is helpful to us as scientists or engineers, and how to do it well (leveraging grade-appropriate element language to help operationalize the SEP or CCC at different grade bands). This discussion is often supported by a text that helps describe what that practice looks like. For example, Unit 3.1 Forces & Interactions intentionally develops Asking Questions and Defining Problems. Throughout the unit, students are supported in asking questions but at one point they specifically engage in revising testable questions. Students also work throughout the unit to identify what their sculptures need to be successful, and later in the unit they name criteria and constraints and work together as a class to define a new problem with agreed-upon criteria and constraints.
2. **Supports a gradual release of scaffolds toward grade-appropriate independent student use of the SEP or CCC as described by elements at that grade band.** Throughout a unit, students may be supported by various tools (e.g., graphic organizers, a set of prompts or sentence frames) and/or guidance (e.g., teacher directions with the whole class, working in small groups or with a partner, working independently). Earlier in the unit, students have more support (e.g., the teacher guiding the class in use of a tool) and later in the unit students have less support (e.g., using a tool or practice independently or in pairs/small groups). For example,

Unit 4.1 Energy Transfer: Collisions intentionally develops the SEP Planning and Carrying Out Investigations. The class begins by working together as a whole group to create a kick system they can use to investigate the effects of different kicks and after initial investigations, small groups of students continue planning additional investigations using the same system. By Lesson 6, students are ready to individually plan an investigation, which they then share with a partner and small group to carry out. Students have support from co-constructed checklists and other resources throughout the unit.

3. **Uses elements of this SEP or CCC in lesson-level Learning Goals, especially focusing on those identified in the unit's PE bundle.** When an SEP or CCC is intentionally developed, elements of that practice or concept, both those identified in the unit's PEs and additional ones, appear in the work of the lessons. For example, one of the PEs in Unit K.2 Weather includes element DATA-P3, so that element is used repeatedly in the work of the unit. However, lessons also include DATA-P1 and DATA-P2 because they support intentional development of the overall practice. One of the PEs in Unit 5.4 Sun, Moon, & Star Patterns includes SPQ-E1, so that element is used repeatedly in the work of the unit. However SPQ-E2 is also essential to the work of the unit, even though it is not mentioned in the PE. Using multiple elements of an SEP or CCCs supports students in broadening and deepening their understandings of these practices and concepts.
4. **Provides an opportunity to use the SEP or CCC to make sense of ideas in the context of a new anchoring phenomenon.** To fully develop students' use of an SEP or CCC, they need multiple opportunities to use the practice or concept in various contexts. For elementary-aged students, working to explain a new anchoring phenomenon in each unit provides a new context for them to make sense of (even if it falls into the same science domain). Thus, there are often multiple units that intentionally develop a SEP or CCC. For example, Units 4.1 and 4.2 both intentionally develop the practice of Planning and Carrying Out Investigations as students figure out ideas about energy transfer. However in Unit 4.1, they are working to make sense of what makes objects like soccer balls move, and in Unit 4.2, they are trying to figure out why some clocks plug into a wall and how they can know the time without being set. These two anchoring phenomena provide different contexts for students to plan and carry out investigations regarding collisions (Unit 4.1) and electrical currents (Unit 4.2), even though both are categorized as physical science units. Likewise, Cause and Effect is intentionally developed in all four kindergarten units so students can use this CCC to make sense of a variety of phenomena: the Sun causing surfaces to feel warm, patterns of weather causing people to prepare

for them, how pushes and pulls affect the motion of objects, and how humans' use of natural resources affects plants and animals. In combination, these varied opportunities using Cause and Effect to explain what students notice about the world supports kindergartners in deepening their understanding of this concept.

5. **Repeats use of target elements across lessons within the unit.** Repetition provides helpful practice as students, particularly young students, are learning new skills and concepts. When a unit intentionally develops an SEP or CCC, that practice or idea will be used across multiple lessons in that unit, potentially across various phenomena. For example, in Unit 3.4 Ecosystem Change & Survival, students are working to respectfully provide and receive critiques from peers by citing relevant evidence and posing specific questions (element ARG-E3). In Lesson 8, students use a structured feedback tool as they give and receive feedback on their use of evidence to support claims about why a manatee joined a pod of dolphins. In Lesson 12, students use a similar tool with additional prompts to support them in giving and receiving feedback on each other's design solutions for protecting manatees. Then in Lesson 13, students again give and receive feedback on arguments, but about a new situation (protecting sea turtle babies from light pollution) and with less structured guidance.
6. **Contains assessment opportunities, often multiple times, for elements of this SEP or CCC.** An integral part of intentionally developing an SEP or CCC is providing opportunities for students to receive feedback as they progress. Thus, three-dimensional assessments in the unit typically draw multiple times on the intentionally developed SEPs and CCCs so that students have an opportunity to respond to feedback and demonstrate growth. For example, Unit 1.3 Sky Patterns intentionally develops Patterns and provides formative or summative assessment opportunities in all 10 lessons. Unit 2.4 Plants intentionally develops Planning and Carrying Out Investigations, supported by formative or summative assessments in 6 of the unit's 10 lessons.
7. **Often includes not-yet-used elements of the SEP or CCC.** Some SEPs or CCCs include a wide range of elements that cannot be used coherently in one unit. For example, the CCC of Energy and Matter at grades 3-5 includes elements about both energy transfer and the particulate nature of matter. The energy transfer element is used extensively in Units 4.1 Energy Transfer: Collisions and 4.2 Energy Transfer: Electricity to support intentional development of Energy and Matter. Then Units 5.1 Ecosystems & Matter Cycling and 5.2 Matter Properties also intentionally develop Energy and Matter, but add the elements related to matter.

The Unit Provides an Opportunity to Practice the SEP or CCC

In contrast to Intentionally Developed, units provide an Opportunity to Practice an SEP or CCC when students authentically use elements of those practices or concepts in the work of the unit but without specific scaffolds or supports across lessons. Even though they are not intentionally developed, these SEPs and CCCs play an important role in the work students do in the unit, providing a chance to deepen their experience working with that practice or concept.

Why is this important? SEPs and CCCs marked as Opportunities to Practice support the work students do in the unit. While important for supporting the work in the unit, students can engage in the work of the unit using these SEPs and CCCs without focusing on them as learning targets.

A unit that provides an opportunity to practice a particular SEP or CCC typically includes any of the following characteristics.

1. **Provides opportunities for students to have experience working with the SEP or CCC because it is necessary for their sensemaking (even before it is intentionally developed).** Because the three dimensions of NGSS work together, the use of an SEP or CCC is often central in the work of developing and using DCIs. In units where an SEP or CCC is defined as an Opportunity to Practice, students use that practice or concept to do the work of figuring out science ideas. For example, in Unit 3.2 Weather & Hazards when students have an opportunity to practice using Scale, Proportion, and Quantity, they use standard units of measurement for precipitation and temperature and consider time scales represented in their data to develop an understanding that climate is the long-term pattern in temperature and precipitation that happens in a place. This CCC receives more direct attention in the following unit (3.3) that intentionally develops this CCC.
2. **May include elements of the SEP or CCC in some lesson-level Learning Goals and assessment opportunities.** Some practices and crosscutting concepts are particularly useful at certain moments in a storyline unit. For example, Asking Questions and Defining Problems is a necessary move especially at the beginning of these units because students' questions drive what they investigate and figure out, so that practice is used in every unit. However, in units where it is not intentionally developed, like Unit 3.3 Trait Variations, it is only included in the Learning Goal for Lesson 1, and is only assessed formatively. (Other units may not assess it at all.) Likewise, Developing and Using Models is a critical practice when communicating the ideas students have figured out or are not sure about yet, such as when they check in on their progress throughout a unit. So there are opportunities to practice

Developing and Using Models in almost every unit in the program, such as Unit 1.4, where students develop drawn and physical models of design solutions that mimic how plants and animals use their parts, but the practice of Developing and Using Models itself is not assessed.

3. **However, the unit does not explicitly scaffold or support use of the SEP or CCC and may not offer repeated opportunities to use the SEP or CCC.** These characteristics are associated with Intentionally Developed SEPs and CCCs.

Appendix C: SEP Progressions - A Detailed Look

In this Appendix, we consider each SEP and describe how students build the elements of the SEP across the program. We use the SEP elements as defined in NGSS Appendix F, and for ease of reference, we have used the SEP, CCC, and element codes from *The NSTA Atlas of the Three Dimensions* (Willard, 2020). The following tables present the elements of each SEP followed by a table showing the progression of the SEP across the grade bands K-2 and 3-5.

Asking Questions and Defining Problems (AQDP)

Grades K-2 Elements of Asking Questions and Defining Problems

SEP Element	Description of Elements in Grades K-2
AQDP-P1	Ask questions based on observations to find more information about the natural and/or designed world(s).
AQDP-P2	Ask and/or identify questions that can be answered by an investigation.
AQDP-P3	Define a simple problem that can be solved through the development of a new or improved object or tool.

Grades K-2 Progression for Asking Questions and Defining Problems

Unit	Support for Growth in Asking Questions and Defining Problems in Grades K-2
K.1 Energy: Sunlight	**Opportunity to Practice:** Students practice asking questions frequently throughout the unit, such as when gathering ideas on the Notice and Wonder chart (AQDP-P1). Students define the problem of the blacktop getting too hot in the sun and plan how to solve that (AQDP-P3).
K.2 Weather	**Intentionally Developed:** Students' use of this practice begins when they share their wonders about their firsthand observations of the local weather and how they prepare for it, and about the weather they and others have experienced (AQDP-P1). Students also use an infographic to support them in identifying specific question words, and the class continues to use this infographic as a resource when asking questions throughout the unit. Students' investigations are motivated by their questions about different weather conditions. During each of these lessons, the teacher continues to prompt students for new questions, based on their observations of and experiences with weather conditions that can be extreme. Later, the teacher supports the class in generating questions about their typical local weather, which they then answer by compiling the data they have gathered through the unit so far. Finally, students ask questions about severe weather and how we can find out information about it, leading them to

Unit	Support for Growth in Asking Questions and Defining Problems in Grades K-2
	obtain information from a book about how meteorologists forecast weather and how communities prepare for those events (AQDP-P2).
K.3 Forces in Motion	**Opportunity to Practice:** Students practice asking questions and defining problems throughout the unit as they observe how objects move and generate questions to investigate motion (AQDP-P2), beginning with a class Notice and Wonder chart (AQDP-P1). Later in the unit, students define a problem about how to design a game that moves a ball to a goal (AQDP-P3).
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Opportunity to Practice:** Students practice asking questions frequently throughout the unit, such as when gathering ideas on the Notice and Wonder chart about reading in darker spaces (AQDP-P1). Whole group discussion prompts also help students recognize when the questions they are asking can be answered by an investigation (AQDP-P2).
1.2 Waves: Sound	**Opportunity to Practice:** Students ask questions throughout the unit based on observations of a clock tower, handbell, and other objects that make and send sound signals (AQDP-P1). Students define a simple problem when they decide to communicate good news messages across the classroom, which motivates designing their own sound signal devices (AQDP-P3).
1.3 Space: Sky Patterns	**Opportunity to Practice:** Students ask questions based on observations of objects that appear in the sky only at certain times, such as taking evening walks when the Sun is still out, or noticing the Moon at night but not every night, which drive their science work (e.g., investigating the Sun's location in the sky) across lessons (AQDP-P1).
1.4 Animal & Plant Traits	**Opportunity to Practice:** Students ask questions based on images, videos, and connections to their home and community to figure out how plant and animal parts help them live and grow (AQDP-P1). Some of these questions are identified as ones that can be answered in future investigations (AQDP-P2). At the end of the unit, students ask questions and define simple problems that can be solved by designing objects or tools inspired by how plants and animals use their parts (AQDP-3). Defining problems in this unit is more complex than in prior units because students brainstorm problems on their own; they are not decided as a whole class.
2.1 Earth: Land Changing Shape	**Intentionally Developed:** At the beginning of the unit, students work as a class with teacher support to ask questions based on their observations of a newscast report of land changes. Farther into the unit, students work on their own to ask and record questions about their investigation observations. (AQDP-P1) Also in this unit, students define problems for which they need to create an object or a tool. Early in the unit, students are supported by the teacher as they define the problem of needing a way to model their land and test their ideas about how land could be changing shape. Then later in the unit, students work in small groups to define a new problem from multiple community land change options and determine that they need to create a new tool to test their ideas. (AQDP-P3)

Unit	Support for Growth in Asking Questions and Defining Problems in Grades K-2
2.2 Structure & Properties of Matter	**Opportunity to Practice:** Students practice asking questions and defining problems when they ask questions about toys and what they are made from after reading a book about different toys around the world. Students also ask questions when they interview kindergartners to find out what kind of toy they would like. (AQDP-P1)
2.3 Habitats & Biodiversity	**Opportunity to Practice:** Students ask questions about the plants and animals in the schoolyard, national parks, and the different features of those places. These questions drive their investigations about the patterns in land, water, plants, and animals in national parks throughout the unit, and they continue to ask new questions when revisiting the Notice and Wonder chart in each lesson. (AQDP-P1)
2.4 Plants	**Opportunity to Practice:** Students ask questions based on observations of the Tower Tree and plants in their schoolyard, which drive finding more information about the natural world (AQDP-P1). In particular, students' questions based on observations of seeds drive investigations at the beginning of the unit. Later in the unit, students ask questions about how plants can keep growing in different places that are answered by a multi-lesson investigation (AQDP-P2).

Grades 3-5 Elements of Asking Questions and Defining Problems

SEP Element	Description of Elements in Grades 3-5
AQDP-E1	Ask questions about what would happen if a variable is changed.
AQDP-E2	Identify scientific (testable) and non-scientific (non-testable) questions.
AQDP-E3	Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
AQDP-E4	Use prior knowledge to describe problems that can be solved.
AQDP-E5	Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Grades 3-5 Progression for Asking Questions and Defining Problems

Unit	Support for Growth in Asking Questions and Defining Problems in Grades 3-5
3.1 Forces & Interactions	**Intentionally Developed:** Throughout the unit, students focus on developing different aspects of this practice. At multiple points in the unit, students ask questions about why sculptures balance and move the way they do and publicly share and organize them onto the Driving Question Board (AQDP-E1). Early in the unit, students are provided with example investigation questions, but increasingly generate their own investigation questions in later lessons with a particular emphasis on cause-and-effect relationships (AQDP-E3). The unit also includes a

Unit	Support for Growth in Asking Questions and Defining Problems in Grades 3-5
	scaffolded activity where students turn closed-ended testable questions into more open-ended testable questions (AQDP-E2). This unit also supports students in beginning to define a simple problem, going farther than they did in grades K-2 by specifically describing criteria and constraints. While students have been tracking what sculptures need to do and how they are limited, they are explicitly introduced to the terms "criteria" and "constraints," and they apply these ideas when they create a sculpture design that uses magnets (AQDP-E5).
3.2 Weather & Hazards	**Opportunity to Practice:** Students ask questions explicitly as they encounter and try to make sense of the anchoring phenomenon of why we can get certain fruits all year, both at the beginning of the unit and across lessons as new questions come up; they share, organize, and check in on questions using the Driving Question Board as they investigate (AQDP-E3). Students also define a problem using criteria and constraints about wind damaging crops (AQDP-E5).
3.3 Trait Variations	**Opportunity to Practice:** Students ask questions frequently throughout the unit, such as when posting questions to the Driving Question Board. They also move answered questions from the Driving Question Board to Our Growing Ideas chart. Students receive additional support around asking questions and reflecting on the role of asking questions in science. (AQDP-E3)
3.4 Ecosystem Change & Survival	**Opportunity to Practice:** Students ask questions explicitly as they encounter and try to make sense of the anchoring phenomenon of why a manatee joined a group of dolphins, both at the beginning of the unit and across lessons as new questions come up; they share, organize, and check in on questions using the Driving Question Board as they investigate (AQDP-E3).
4.1 Energy Transfer: Collisions	**Intentionally Developed:** Students wonder about the motion of a soccer ball due to various kicks, and they seek out related phenomena to motivate further questions. Students develop a Driving Question Board using question starters to help them write open-ended questions that they can investigate (AQDP-E1). Students are reintroduced to testable (scientific) and non-testable questions and collaboratively create testable questions (AQDP-E2). As students proceed through the unit and plan investigations, they also make "if…then…because…" predictions, first as a class and then with growing independence. These investigations address their testable questions based on cause-effect patterns of energy transfer they have observed (AQDP-E3).
4.2 Energy Transfer: Electricity	**Intentionally Developed:** Students share their wonderings about how some devices they use to tell time always know what time it is without having to be set. To help them figure this out, the teacher facilitates an Initial Ideas Discussion about the different ways that we could communicate information, and students bring their prior knowledge to the conversation (AQDP-E4). The class works together to define the specific problem they want to solve: How can we communicate time information across a distance? They realize they need to gather more information about how to design solutions to problems, so they read a book to gather evidence about the engineering design process. After reading, they identify the criteria they will use to make their designs a success and the constraints they should consider when designing them. At the end of the unit, students have an opportunity to independently define a problem (how to power and communicate with a Mars rover) by identifying the criteria and constraints

Unit	Support for Growth in Asking Questions and Defining Problems in Grades 3-5
	that should be considered. (AQDP-E5) Building on their understanding of defining problems, students decide to evaluate the effects of plugging in their devices and use their prior knowledge about usable energy sources to describe the problem of choosing a power source for their own community (AQDP-E4).
4.3 Earth Processes	**Opportunity to Practice:** Students ask questions as they create their Driving Question Board, brainstorm ideas for investigating those questions, and generate and add new questions throughout the unit (AQDP-E3). Students also define the problem of weathering and erosion impacting the Seawall Road in Acadia National Park, including developing criteria and constraints for possible design solutions (AQDP-E5).
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Opportunity to Practice**: Students ask questions frequently throughout the unit, such as when they gather and organize ideas on the Driving Question Board. Students identify criteria for testable questions as they ask questions about moss, and again when they prepare to investigate where the matter in the nurse log goes when it seems to disappear (AQDP-E2).
5.2 Matter Properties	**Intentionally Developed:** Students ask questions about what makes water healthy or unhealthy and about how they could design a way to make an unhealthy water sample healthy again (AQDP-E3). Students apply what they figured out from earlier grade levels about defining engineering problems using criteria and constraints: they work in small groups to define a design problem around water for a community that can be solved through the development of an object, tool, process, or system for filtering water. At the end of the unit, students work independently to define a problem with the water in a turtle tank and consider a solution that would meet the criteria and constraints of the problem. (AQDP-E5)
5.3 Earth Systems	**Not Claimed**
5.4 Sun, Moon, & Star Patterns	**Opportunity to Practice:** Students ask questions throughout the unit to motivate their investigations and check in on their questions periodically to see which they can answer and what new questions they now have (AQDP-E3).

Developing and Using Models (MOD)

Grades K-2 Elements of Developing and Using Models

SEP Element	Description of Elements in Grades K-2
MOD-P1	Distinguish between a model and the actual object, process, and/or events the model represents.
MOD-P2	Compare models to identify common features and differences.
MOD-P3	Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).
MOD-P4	Develop a simple model based on evidence to represent a proposed object or tool.

Grades K-2 Progression for Developing and Using Models

Unit	Support for Growth in Developing and Using Models in Grades K-2
K.1 Energy: Sunlight	**Opportunity to Practice:** In this unit, the word "model" is not student-facing; "drawing" or "design" is used instead. The teacher supports students in distinguishing between a model (built design solution) and the actual object when introducing the design problem of keeping the blacktop less hot (MOD-P1). Students construct models to represent their proposed design solutions (MOD-P4). Students compare models (drawings and built designs) to identify common features and differences (MOD-P2). Students also draw (model) to represent the patterns they observed in the natural world: that sunlight warms surfaces and shady surfaces are less hot (MOD-P3).
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Opportunity to Practice:** In this unit, the word "model" is not yet used explicitly with students. Students draw an initial design for their game board, then use that drawing to build their game board designs. Later, they revise and draw a final design to show how the ball moves from the starting point to the ending point in their game, using their model to explain how their design solution works. (MOD-P4)
K.4 Plants, Animals, & Environments	**Intentionally Developed:** Intentional development of this SEP focuses on MOD-P3 as the class co-develops a model to represent the components and relationships involved with birds meeting their needs; other elements support intentional development of the practice in first and second grades. The word "model" is defined and used with students in this unit. As this is students' first explicit experience using models to explain scientific phenomena, the class collaborates with the teacher, first to recognize what components to include and later to consider how to represent relationships. Based on their outdoor observations, the initial class model represents birds and different aspects of their environment. After further investigation, the class revisits the model and adds to it to show the relationship between the needs of birds and the birds' environment. Toward the end of the unit, the class adds ideas about how other plants and animals meet their

Unit	Support for Growth in Developing and Using Models in Grades K-2
	needs in the environment, and students use the model as evidence to support their scientific arguments. Students are supported in several ways while developing this practice: the teacher prompts help them use the model as evidence to support their ideas, and the class uses discussions to make decisions about how the model can use words and pictures to represent the relationships they have figured out. (MOD-P3)
1.1 Waves: Light	**Intentionally Developed:** At the beginning of this unit, students' initial models are supported by whole group planning and a book. They explain why they think it was brighter or dimmer (amounts) under different covers and how to make it easier to read under covers that block light (relationship between light and seeing objects) (MOD-P3). As the unit goes on, students revisit these models and create new ones with varying levels of support. Students also share their models with partners to compare common features and differences in how they represent ideas to explain different aspects of the phenomenon (MOD-P2). Students also have an opportunity to use a physical model (a pinhole box) to represent the classroom in total darkness, dim lighting, and bright lighting as part of an investigation (MOD-P1).
1.2 Waves: Sound	**Intentionally Developed:** Students begin the unit co-developing an initial class model representing tentative relationships in the anchoring phenomenon of a clock tower. Later in the unit, students individually develop models based on evidence they have gathered from their investigations to explain how the clock tower makes and sends its sound signals, and then use those ideas to revise the class consensus model to represent what they have figured out. (MOD-P3) These models are based on evidence students gather from their investigations; later in the unit, students draw and construct models of sound signal devices to address an engineering problem of needing a way to communicate a good news message across the classroom (MOD-P4). In order to help young students clearly discuss their work in this unit and highlight the engineering work they are doing, the word "design" is used to refer to students' engineering drawings and built devices (as was done in Units K.1 and K.3), whereas "model" is used to refer to students' explanations of how objects make sound signals.
1.3 Space: Sky Patterns	**Not Claimed**
1.4 Animal & Plant Traits	**Opportunity to Practice:** Students use their bodies and simple physical objects as models to show how the structures of roots, stems, beaks, feet, and body color help plants and animals live and grow (MOD-P3). Later, students develop drawn and physical models of their own design ideas that mimic how plants and animals use their parts, using these models to communicate how their proposed solutions could solve movement, protection, getting food, or getting water and sunlight-related problems (MOD-P4). Again in this unit, the word "design" is used to refer to the solutions students draw and build to support their development of ideas around engineering, and "model" is used for the drawings and physical models used to explain phenomena.
2.1 Earth: Land Changing Shape	**Intentionally Developed:** Intentional development of this SEP focuses on MOD-P4 as the class develops land change bins to help them investigate the real-life area where land is changing. The class reconstructs and reuses these land change models for testing their ideas many times throughout the unit. In the second lesson set, students build a new model (an improved version

Unit	Support for Growth in Developing and Using Models in Grades K-2
	of the land change bin) based on the problem they have identified in their community. Students develop this model more rapidly and with fewer scaffolds than they had in the first lesson set. (MOD-P4) Students also develop drawn models to represent the relationships between their engineered structure (aimed at limiting land change) and the natural environment depicted in their community example problem (MOD-P3). Then, students work in pairs to revise these models using multiple sources of evidence (MOD-P4).
2.2 Structure & Properties of Matter	**Intentionally Developed:** This unit uses repetition to support deeper understanding and more independent use of this practice as students design and construct more individualized models than they did in Unit 2.1; this unit still focuses on MOD-P4 as students develop a model (referred to as a design) of a toy they want to build, and continue to update this model throughout the unit. Students use data from their investigations as evidence to support decisions about the materials they include in their designs (MOD-P4). Students use their drawn designs to compare features (MOD-P2), then collaborate to build the physical toy. After designing toys for their own classroom, students repeat the process to design toys for a kindergarten classroom. They interview a kindergartner, then work with a partner to draw a design and use evidence from earlier investigations and the interview to make material choices so that the toy functions in a specific way. Finally, students build the physical toy to present to the kindergarteners (MOD-P4).
2.3 Habitats & Biodiversity	**Intentionally Developed:** This unit explicitly supports students in using maps as models while they work to make sense of ideas about how the places animals and plants live support their needs. At the beginning of the unit, the teacher uses initial student ideas to capture drawn representations of the shape and relative size of land and water features in different areas. The class reads and discusses a book about a scientist who uses maps, and they figure out that each of the maps (models) they develop and/or use represents aspects of the land and water such as patterns (e.g., the lake is surrounded by land) and relative scales including size, shape, and location (e.g., the land part of the map is bigger than the water part). Students work in small groups and then independently to develop maps (models) of an area in the national park they are researching to represent patterns (e.g., presence of different kinds of land features) and relative scales (e.g., symbols for hill and mountain show land that is taller/shorter). (MOD-P3) Students use their independently developed maps (models) to identify common land and water features in the various places the maps represent (MOD-P2). Students are also supported in distinguishing between the land and water in their models (maps) and the land and water in the actual place the model represents (MOD-P1).
2.4 Plants	**Intentionally Developed:** In this unit, students have multiple opportunities to use a wide variety of SEP elements with varying levels of support so that by the end of the unit they are able to individually develop models explaining a phenomenon similar to but not exactly the same as the anchoring phenomenon. The class begins the unit co-constructing a model to represent their initial ideas related to the anchoring phenomenon of how a seed that grew into the Tower Tree could have gotten to the top of the courthouse to start growing and how it can keep growing in that unusual place. Later in the unit, students model to represent relationships and patterns in the natural world. For example, as students gather evidence about seeds and surfaces through investigations, they develop simple models to explain how animals can move seeds to new places (e.g., when a seed sticks to fur or when an animal stores it for food). (MOD-P3) Developing

Unit	Support for Growth in Developing and Using Models in Grades K-2
	and using these models deepens students' understanding of structure-and-function relationships as they are used in different contexts. Students use simple models to figure out if and how bees can move pollen from one flower to another (MOD-P4). In their work, students make connections between actual pollinators/pollination and their models (MOD-P1). In multiple lessons, students compare models to identify common features and differences (MOD-P2). Students end the unit by collaboratively revising their class consensus model to explain how the Tower Tree keeps growing on top of the courthouse, representing patterns in plant growth caused by light and water, then individually modeling to explain how another plant is growing in an unusual place (MOD-P3).

Grades 3-5 Elements of Developing and Using Models

SEP Element	Description of Elements in Grades 3-5
MOD-E1	Identify limitations of models.
MOD-E2	Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.
MOD-E3	Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
MOD-E4	Develop and/or use models to describe and/or predict phenomena.
MOD-E5	Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.
MOD-E6	Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

Grades 3-5 Progression for Developing and Using Models

Unit	Support for Growth in Developing and Using Models in Grades 3-5
3.1 Forces & Interactions	**Intentionally Developed:** Students use diagrams and simple prototype sculptures throughout the unit to figure out and convey how sculptures work (MOD-E5). Students develop ideas for how to represent the strength and direction of forces using arrows (an abstract representation), and the class discusses other different ways they can represent what they figured out through words and pictures (MOD-E3). Students reflect on their initial diagrams and explicitly define models, then continue to develop models to explain how their sculpture designs work (MOD-E4). Some of this work is done collaboratively with whole class models, but most lessons also invite students to develop models on their own and use them to explain how they think something works on their sculptures (MOD-E2, MOD-E3, MOD-E4, MOD-E5).

Unit	Support for Growth in Developing and Using Models in Grades 3-5
3.2 Weather & Hazards	**Opportunity to Practice:** Students use a map and develop a life cycle model as a class (MOD-E4), and develop windbreak models in small groups to show how their design solutions work to protect plants (MOD-E5, MOD-E6).
3.3 Trait Variations	**Intentionally Developed:** Students develop initial models in an attempt to make sense of the phenomenon of newborn puppies looking and acting similar but adult dogs looking and acting so differently. The class works together to use a model to begin to describe why a newborn canine becomes an adult that looks and acts like it does. The class reads a text about how scientists use models to explain, and they revise their model to describe what they have figured out about canine life cycles (MOD-E4). After the class expands this life cycle model to explain other animals (not only canines), it becomes a central artifact to update as students figure out ideas about inheritance (MOD-E6) and to help explain why some animals are no longer found on Earth (MOD-E4). The class also has several explicit discussions during the unit about the limitations of their model (MOD-E1). Students continue to use the model as they make sense of their ideas later in the unit, especially when they consider why some animals are no longer found on Earth (MOD-E4). Since the models and revisions to them in this unit are complex, students develop and revise their models most often as a class with teacher support; however, there are opportunities throughout the unit for students to work independently or with partners to create and use models to explain.
3.4 Ecosystem Change & Survival	**Opportunity to Practice:** Students co-develop and revise a Class Consensus Model that describes the components and interactions in the three water systems (habitats) they investigate, and use it throughout the unit to support their engagement with asking questions, obtaining and evaluating information, and constructing arguments (MOD-E4).
4.1 Energy Transfer: Collisions	**Opportunity to Practice:** Students co-construct and frequently revisit their Class Consensus Model to keep track of their developing ideas about energy and energy transfer (MOD-E4).
4.2 Energy Transfer: Electricity	**Opportunity to Practice:** Students develop an initial model to explain how a plug-in clock turns on and stays on, and they repeatedly revisit their Class Consensus Model to add new ideas and revise their thinking (MOD-E4).
4.3 Earth Processes	**Intentionally Developed:** Students develop and use models to describe wave patterns (including amplitude and wavelength) at several points in this unit. At first, students draw models to attempt to explain how a natural event, possibly involving waves, causes changes to land (damage to a road) (MOD-E4). Then they work in small groups to model wave formation and investigate wave patterns using water waves in a physical model (a wave bin). In order to help observe and name those patterns, the class works together to create waves in a bedsheet, which represents water (MOD-E3). Finally, students have the opportunity to use drawn models independently to describe and explain how wave action caused different land changes (covering and uncovering of a shipwreck on a beach) (MOD-E4).
4.4 Structure & Function	**Intentionally Developed:** Students use models to describe the phenomenon of flying squirrels and other animals (and a plant) using their parts to meet their needs in the dark, which elevates their initial ideas and questions to drive the unit. They revisit the flying squirrel

Unit	Support for Growth in Developing and Using Models in Grades 3-5
	model in several lessons and revise it to include ideas they have figured out about how the flying squirrel structures work together as a system. The class also collaboratively develops models to explain how light reflecting off objects allows flying squirrels to see. Students go on to develop models to explain how animals use their senses to receive and process information, working as a whole group and transitioning to modeling these systems individually. (MOD-E2, MOD-E4)
5.1 Ecosystems & Matter Cycling	**Intentionally Developed:** Students develop and/or use models to describe phenomena in almost every lesson in this unit (MOD-E4), usually working as a class but eventually also in small groups and independently. Their individual and collaborative initial models attempt to explain how a fallen tree becomes a nurse log, and they go on to model ideas about how plants use energy and matter for growth, how plants and animals in the nurse log system meet their needs, and how an inflated basketball is filled with particles of air with space in between them. The class collaboratively develops a model based on evidence that shows matter and energy relationships between wood, a termite, and microscopic organisms (MOD-E2). Students also work together as a small group to develop a model of a healthy and unhealthy food web (MOD-E3). At the end of the unit, students individually develop and use a model to describe how organisms meet their needs in a grassland ecosystem, and what would happen if a new species was added to that ecosystem (MOD-E4).
5.2 Matter Properties	**Opportunity to Practice:** Students develop initial models to explain why they think some of their water samples are unhealthy, and go on to also develop and use models to explain how water that looks clear can still contain matter that is unhealthy. Later in the unit, students develop and use models to explain how a solar still can remove solid matter from water. (MOD-E4)
5.3 Earth Systems	**Intentionally Developed:** This unit explicitly supports students as they model to explain the interaction of Earth's spheres, a larger and more complex system than they have previously modeled. Students begin by modeling how salmon and other living things interact with the Elwha River, and they continue to add components and interactions, describing how those interactions are affected by the damming of the Elwha River (MOD-E3). At one point, students use models to figure out the repeating life stages of salmon in the river (MOD-E2). As the unit progresses, students collect additional evidence and continue to collaboratively update the class system model (MOD-E4). Students are supported with visual scaffolds and specific prompts to represent their thinking to describe and predict phenomena and opportunities for increased independence even as they work to model more complex systems.
5.4 Sun, Moon, & Star Patterns	**Opportunity to Practice:** Students develop models to capture their initial ideas about causes for the apparent motion of the Sun, Moon, and stars in our sky, and revise these models as the unit goes on (MOD-E3, MOD-E4). Students construct and test physical models to explain the causes of the patterns they discover (MOD-E2, MOD-E6).

Planning and Carrying Out Investigations (INV)

Grades K-2 Elements of Planning and Carrying Out Investigations

SEP Element	Description of Elements in Grades K-2
INV-P1	With guidance, plan and conduct an investigation in collaboration with peers (for K).
INV-P2	Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.
INV-P3	Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.
INV-P4	Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons.
INV-P5	Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.
INV-P6	Make predictions based on prior experiences.

Grades K-2 Progression for Planning and Carrying Out Investigations

Unit	Support for Growth in Planning and Carrying Out Investigations in K-2
K.1 Energy: Sunlight	**Intentionally Developed:** Since this is the first time students formally use this practice, the teacher guides students in the planning and carrying out of their investigations, and students always collaborate with the class or a partner (INV-P1). Near the beginning of the unit, the class reads a book about making observations and frequently discusses how scientists record accurate observations and then use their observations to answer their questions. Students also make predictions about how they think surfaces will feel based on their prior experiences (INV-P6). Students use the relative scale of hot and less hot to investigate surfaces throughout the unit and repeatedly use their observations to make comparisons to find patterns in why some surfaces are hot, and others are less hot (INV-P4). Finally, they use the same relative scale when making observations to determine if their design solutions meet the goal of keeping the blacktop less hot (INV-P5).
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Intentionally Developed:** Again in this unit, students collaborate with their peers and have explicit teacher guidance while they plan and carry out investigations. Students begin the unit by conducting an investigation to explore how different objects move using different strengths and directions of pushes and pulls, predicting and observing how these changes affect the motion of toy cars (INV-P6). The class reads a book about using investigations to answer their questions, and students also use picture cards to support this practice, gradually releasing responsibility as students move from whole-class planning to working in small groups. (INV-P1) Students go on to

Unit	Support for Growth in Planning and Carrying Out Investigations in K-2
	demonstrate greater independence to plan their investigation with a partner and test different strengths and directions of pushes and make observations to collect data about how collisions affect the motion of a ball (INV-P4). Finally, students collect data and make observations to determine whether their design solutions solve the engineering problem, building on their earlier experience conducting investigations about motion (INV-P5).
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Intentionally Developed:** In first grade, the purpose of planning and carrying out investigations becomes more focused: students want to produce data that can be used as evidence to answer their questions. As students collaborate to plan investigations to answer their questions about reading under different covers, they read a book about how scientists select and use materials to make observations that can be used as evidence to answer their questions. Students then use these ideas with the support of guided discussion prompts to plan and carry out investigations to determine the effects of placing different materials in the path of a beam of light. (INV-P2) Within those experiences, students make predictions when they offer ideas for what they might observe prior to carrying out an investigation (INV-P6). They also make firsthand observations that are used to compare and make sense of the effects of shining light on different materials (INV-P4). Throughout this unit, students gain independence with this practice, moving from whole-class planning, to small group work, to partner work.
1.2 Waves: Sound	**Intentionally Developed:** After initial play and exploration with bells, students plan and carry out multiple investigations collaboratively to produce data that serves as the basis for evidence to answer their questions about how objects make sounds and how we can know that sounds travel and are received (INV-P2). The class reads and discusses a book about how scientists make and use observations, then work together to use planning and data collection tools that students use later with small groups and partners as the unit goes on. During their investigations, students make firsthand observations using multiple senses to gather data used to make comparisons when they are and are not making sounds (INV-P4). At the end of the unit, students work individually and with partners and apply what they have figured out about making observations to determine if their sound signal devices work as intended to solve their engineering design problem (INV-P5).
1.3 Space: Sky Patterns	**Intentionally Developed:** In this unit, students plan and carry out investigations collaboratively to gather observational data in the context of the sky. Their investigation data of the Sun, Moon, and stars serve as the basis for evidence to answer their questions (INV-P2). Over multiple lessons, students make observations (firsthand and from media) of the Sun's location in the sky at different times and in different places; comparing these data allows students to describe the pattern of the Sun's apparent motion in the sky. Students make observations from media of the Moon's location in the sky, making comparisons to describe the pattern of the Moon's apparent motion in the sky and to identify that it is the same as the Sun's. Students also make and compare observations of both the sky and objects in it to answer questions about daytime and nighttime skies (INV-P4). Students make predictions about the Sun's location in the sky based on prior experiences, which (over the course of the unit) include the formal observations that

Unit	Support for Growth in Planning and Carrying Out Investigations in K-2
	students are making (INV-P6). Over the course of the unit, students carry out investigations as a whole class, with partners, and independently.
1.4 Animal & Plant Traits	**Opportunity to Practice:** Students work with partners to plan how to observe images and videos so they can collect data about how individuals of the same kind are similar or different. Students also carry out an investigation to compare what happens to stems, leaves, and flowers when they are placed in water and food coloring. (INV-P4)
2.1 Earth: Land Changing Shape	**Opportunity to Practice:** Students practice collaboratively planning and carrying out investigations and using the data to make comparisons throughout the unit, such as when they investigate using different versions of land change bins in many lessons (INV-P2, INV-P4). Students also make predictions based on their prior experiences with the land change bins as they plan subsequent investigations (INV-P6).
2.2 Structure & Properties of Matter	**Opportunity to Practice**: Students practice collaboratively planning and carrying out investigations when they collaborate with peers to decide how to test the properties of materials (INV-P5).
2.3 Habitats & Biodiversity	**Intentionally Developed:** In second grade, students intentionally develop their use of this practice from prior grades by planning and carrying out investigations in a new context and on a larger scale, making more complex observations that result in more data to use to answer their questions. Students in this unit make firsthand observations of plants and animals in their schoolyard to answer their questions about what lives where. Then they plan and carry out investigations where they make observations from media (e.g., picture cards, an article, a website) to figure out what kinds of plants and animals live in various national parks. Students also make and compare detailed observations of solid and liquid water to figure out that temperature determines whether water is solid or liquid. Students are supported in these investigations by their teacher and classmates over the course of the unit (whole group, small group, and partners), and also through the use of tools to help them make comparisons, especially across the many plants and animals they are investigating (e.g., labels for relative sizes or numbers of legs). (INV-P2, INV-P4)
2.4 Plants	**Intentionally Developed:** The final second grade unit has students collaboratively and individually plan and carry out more complex investigations than they did in earlier grades to answer questions about how seeds get moved to new places and what plants need to keep growing. Early in the unit, students make detailed observations of seeds and surfaces, using tools and multiple materials to collect data that can be used to make comparisons (INV-P4). These data provide evidence that structures of seeds and animals work together to make it possible for seeds to be moved to new places (INV-P2). Later in the unit, students plan an investigation to make firsthand observations and measurements of plants in different light and water conditions to collect data that can be used to make comparisons of the plants' growth (height and number of leaves) and health (color and appearance) (INV-P4). They plan that investigation in small groups, each observing multiple plants, and observations are ongoing over multiple days with students gaining independence so they are making their final observations individually (INV-P2). Then students compare data across multiple investigation groups to

Unit	Support for Growth in Planning and Carrying Out Investigations in K-2
	identify patterns in their observations of different plants (effects) and connect these to the plants' different conditions (cause) (INV-P4).

Grades 3-5 Elements of Planning and Carrying Out Investigations

SEP Element	Description of Elements in Grades 3-5
INV-E1	Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
INV-E2	Evaluate appropriate methods and/or tools for collecting data.
INV-E3	Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
INV-E4	Make predictions about what would happen if a variable changes.
INV-E5	Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

Grades 3-5 Progression for Planning and Carrying Out Investigations

Unit	Support for Growth in Planning and Carrying Out Investigations in Grades 3-5
3.1 Forces & Interactions	**Intentionally Developed:** As they build and test sculptures, students figure out how to read and follow procedures, how to modify procedures for clarity, how to make note of observations and record data as they carry out the investigation procedures, how to change "one thing at a time" (the term variable is not used in this grade level) to ensure a fair test in their investigations, and how to use multiple trials of each test (INV-E1, INV-E3). Students continue to plan and carry out investigations to explore cause-and-effect relationships with magnets. Their findings are used as the basis for explanations of how they think the sculptures are working or how they can design either a sculpture or a solution to a problem (INV-E3). They also make a prediction about what would happen if they changed a variable, such as changing the balance point, or the size of force applied, and then practice changing questions to "If we do ___, what will happen?" types of questions (INV-E4). This work is supported by collaborative planning, a book about using procedures, explicit discussions, small group work, and peer feedback to support individual work.
3.2 Weather & Hazards	**Not Claimed**
3.3 Trait Variations	**Not Claimed**

Unit	Support for Growth in Planning and Carrying Out Investigations in Grades 3-5
3.4 Ecosystem Change & Survival	**Not Claimed**
4.1 Energy Transfer: Collisions	**Intentionally Developed:** Students use a physical kick system to collect data and carry out investigations about what happens after a kick and establish the importance of fair tests and the number of trials (INV-E1, INV-E3). Based on conversations that students have about testable questions, fair test investigations, making predictions, and analyzing data, they are introduced to a Fair Test Investigation infographic that they use to guide the evaluation of investigation plans in later lessons (INV-E2, INV-E4). Students also work in small groups to evaluate and complete investigation plans, then give and receive peer feedback to inform revisions to their plans (INV-E1, INV-E2). Building on their work from third grade, the word "variable" is introduced and used in fourth grade, and students have multiple opportunities to evaluate appropriate methods and/or tools for collecting data (INV-E2).
4.2 Energy Transfer: Electricity	**Intentionally Developed:** Students make observations to serve as the basis for evidence for an initial model explaining why plug-in clocks turn on and stay on. Students continue their progression through this practice when they make additional observations to gather evidence of energy transfer, observing how electrical current transfers energy from place to place in a complete path, exploring how electrical current moves through power lines to get into the school and through wires to their classroom outlets, and gathering evidence for how wind can be used to generate electricity (INV-E3). Later, students' engagement with this practice increases in complexity as they consider how to carry out a fair test investigation that will help them understand how sunlight is a usable energy source; they determine they should test solar panels in the sun and shade to try to make a motor move (INV-E1). Finally, students plan and carry out a fair test investigation to help them test, refine, and optimize their design solution for communicating the time across their classroom (INV-E1). Students' work in this unit is supported by class discussions and guiding questions, structured handouts, a book about engineering, and opportunities to work with increasing independence.
4.3 Earth Processes	**Intentionally Developed:** In this unit, students focus specifically on using one element of this practice across multiple lessons, making observations that they use to support their explanations of how and why land is changing. Students plan and carry out investigations that help them make observations of patterns of wave motion, in water wave tanks and with a bedsheet "parachute." They begin as a class with significant scaffolding from the teacher, then work in small groups with the same materials in later lessons. Students use their observations as data to serve as the basis for explaining how waves can cause objects to move in different ways. Then, students observe images of various national park sites and in their own communities to produce data to support their explanations of weathering and erosion working by mechanisms beyond only water (e.g., wind, plant growth, earthquakes, etc). Students do some of that work with a small group or partner, and some individually. Later in the unit, students have an individual opportunity to apply what they have figured out about making observations to produce data to use as evidence for their explanation of land changing around a shipwreck. (INV-E3)

Unit	Support for Growth in Planning and Carrying Out Investigations in Grades 3-5
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Opportunity to Practice:** Students practice evaluating investigation design, methods, and/or tools on how to measure matter and what factors help plants grow (INV-E1, INV-E2). Students also make observations and measurements to use as evidence to explain how different types of organisms get and use energy and matter (INV-E3).
5.2 Matter Properties	**Intentionally Developed:** In this unit, students focus on planning and carrying out investigations to support their engineering designs for water filters. Students work as a class to plan an investigation to test their filter design, considering how to ensure it is a fair test, and then carry it out (INV-E1). Students also propose changes to their filter design, predict how that will change the cause-and-effect relationships, and then work in small groups to test the redesigned filter to see if it is more successful than before (INV-E4, INV-E5). At the end of the unit, students work in small groups to test different proposed solutions for a community water problem, and determine which better meets the criteria for success (INV-E5). Throughout the unit, students also work in small groups to plan and conduct investigations to make observations of various water samples in order to produce data they can use to support their explanations of the matter in each sample (INV-E1, INV-E3).
5.3 Earth Systems	**Not Claimed**
5.4 Sun, Moon, & Star Patterns	**Not Claimed**

Analyzing and Interpreting Data (DATA)

Grades K-2 Elements of Analyzing and Interpreting Data

SEP Element	Description of Elements in Grades K-2
DATA-P1	Record information (observations, thoughts, and ideas).
DATA-P2	Use and share pictures, drawings, and/or writings of observations.
DATA-P3	Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
DATA-P4	Compare predictions (based on prior experiences) to what occurred (observable events).
DATA-P5	Analyze data from tests of an object or tool to determine if it works as intended.

Grades K-2 Progression for Analyzing and Interpreting Data

Unit	Support for Growth in Analyzing and Interpreting Data in K-2
K.1 Energy: Sunlight	**Intentionally Developed:** Since this is students' first formal use of this practice, there are several scaffolds used in the unit to support their development, and students interpret data as a whole class throughout the unit. Students are provided with ready-made tables to record their observations for each investigation so their drawings and writings are easier to share and compare with partners and the whole class, such as when they use their observations to identify patterns about surfaces in sunny and shady places (DATA-P1, DATA-P2). The teacher supports students in class discussions as they use those patterns to answer their question about why some surfaces are hot, and others are less hot (DATA-P3). Then, when students test their engineering designs, they work as a class to construct a physical chart on the floor based on their data from testing their engineering designs, in order to determine if their solutions worked as intended to make the blacktop less hot (DATA-P5).
K.2 Weather	**Intentionally Developed:** Again in this unit, students' development of this practice is supported by frequent whole-class work and direct teacher guidance. Students are provided with age-appropriate handouts that include an image of the weather tool(s) they use in that lesson to support them as they record data. Each time students investigate a new weather condition, the teacher supports the whole class in recording observations, and then in subsequent lessons, students record their observations in smaller groups with increasing independence (DATA-P1). Each time they collect weather condition data, the teacher supports the whole class in sharing their observations and using them to identify patterns of typical weather (DATA-P2). Also, the sequence of weather condition investigations in the unit is intentional to build complexity with this practice: students begin making observations of weather conditions that are simpler to observe and likely most familiar to them (temperature on a color scale and how sunny/cloudy the sky is), then they move to making quantitative observations of precipitation amounts, and end with observations of wind using a light-moderate-strong scale. The class works together later in the unit to describe patterns in the data they have gathered from their firsthand observations across multiple days in order to answer their questions about what the weather is usually like and how we can prepare for it (DATA-P3).
K.3 Forces in Motion	**Intentionally Developed:** In this unit, students are supported in using all elements of this practice. Students analyze and interpret data as they investigate how different strengths, directions, and collisions affect an object's motion. Students record and share observations of how an object moves after being pushed or pulled, using drawings to represent direction (DATA-P1, DATA-P2). They compare predictions of how a collision might affect a toy car's motion to what they observe in their investigations (DATA-P4). Students describe patterns in motion (such as speed and direction) and analyze how strength and collisions influence those patterns (DATA-P3). Students use and reflect on data from tests of their engineering designs to determine if the ball moves through the path as intended, using data to explain the effectiveness of their design solutions (DATA-P5). To begin the unit, students have more structured support in this practice, but as the unit goes on, they transition to analyzing and interpreting data with more independence, including partner work throughout and an individual opportunity at the end.

Unit	Support for Growth in Analyzing and Interpreting Data in K-2
K.4 Plants, Animals, & Environments	**Opportunity to Practice:** Students practice analyzing and interpreting data when they use their observations (firsthand and from media) to describe patterns in the needs of plants and animals, which answer their questions about whether plants and animals need people to help them live (DATA-P3).
1.1 Waves: Light	**Opportunity to Practice:** Students practice analyzing and interpreting data throughout this unit when they record their observations, thoughts, and ideas in data tables during investigations and models at key sensemaking moments in the unit (DATA-P1). They use and share pictures, drawings, and/or writing of observations in small and whole group discussions, often while adding to Our Growing Ideas chart (DATA-P2). Students also compare pre-investigation predictions with what they observed happens when they carry out those investigations (DATA-P4).
1.2 Waves: Sound	**Opportunity to Practice:** In the first part of this unit, students record observations (DATA-P1) and share their drawn and written observations (DATA-P2) when different objects are and are not making sound. Students are able to use these and other firsthand observations to describe patterns in cause-and-effect relationships that answer their questions about materials and sound (DATA-P3). In the second lesson set, students use observations of sound signal devices to describe patterns (categories) of different messages people use the devices to send (DATA-P3). Students also analyze data from tests of their built sound signal devices to determine if they worked as intended (DATA-P5).
1.3 Space: Sky Patterns	**Intentionally Developed:** In first grade, this practice is developed by supporting students in making sense of larger and more complex data sets than they had in kindergarten. Across multiple days and at multiple times (morning, midday, afternoon), students record observations of the Sun's location in the sky in relation to ground-based reference points (DATA-P1). They use these many firsthand observations, along with observations from photographs (media), to describe the pattern of the Sun's changing locations in the sky and its apparent motion. Students also use observations from images (media) to describe the Moon's similar pattern of changing locations and apparent motion. They also use observations from photographs (media) of the sky and objects in it to describe patterns to answer questions about what makes it daytime or nighttime. At the end of the unit, students work individually and as a class to use another first grade class's recorded observations (daytime and nighttime hours over a whole year) to describe seasonal patterns in daytime length and answer questions about how evening events can sometimes happen in the daytime or nighttime. (DATA-P3)
1.4 Animal & Plant Traits	**Not Claimed**
2.1 Earth: Land Changing Shape	**Intentionally Developed:** In second grade, students use the same elements of this practice but with less scaffolding and more independence than in prior years. In this unit, students make and record their observations of the changes to the shape of land in their land change bins (DATA-P1). Students then use multiple sources of data (observations from the bins, their Community Examples chart, and other class investigations) to identify patterns in the type and duration of land changes that occur from wind and water (DATA-P3). After experiencing initial examples together as a class, students have more opportunities across the unit to record

Unit	Support for Growth in Analyzing and Interpreting Data in K-2
	observations individually, then share with the group (DATA-P2). Students also engage in making predictions about the outcomes of a test based on their prior experiences with the land change bins, and revisit those predictions after their investigation (DATA-P4). At the end of the unit, students work with small groups to test their design solutions and use data from those tests to determine if they worked as intended (DATA-P5).
2.2 Structure & Properties of Matter	**Intentionally Developed:** Again, the gradual release of responsibility moves more quickly in this unit as students investigate materials and objects they can use to build their toys (first for their own classroom, then for kindergartners). With varying levels of support across lessons, students interpret observations (often firsthand and sometimes from media) to describe patterns across properties and materials (e.g., the flexible category has a lot of items made of plastic). Students independently analyze the property data to make decisions about the materials they will use to build their toys, and return to their data to determine if the property of the material will help the toy to function in a specific way. Students individually use their observations to describe patterns in the properties of materials to support a written argument for their material choice. (DATA-P3) At the end of the unit, students work with a partner to analyze data from tests of their toys to determine if the materials and toys function the way that a kindergartner specified (DATA-P5).
2.3 Habitats & Biodiversity	**Opportunity to Practice:** Students record observations and ideas about land, water, plants, and animals (DATA-P1). They also use and share pictures, drawings, and/or written observations in small and whole group discussions, often while adding to Our Growing Ideas chart (DATA-P2).
2.4 Plants	**Opportunity to Practice:** Students record observations of plants outside in their schoolyard, of seeds and surfaces, and of plants in different water and light conditions during their multi-lesson plants investigations (DATA-P1). Students share their recorded observations using handouts and data tables (DATA-P2). Students are able to use these firsthand observations to describe patterns in the structures of seeds and surfaces that stick together and to identify and describe the pattern between plants' conditions and observed growth and health (DATA-P3).

Grades 3-5 Elements of Analyzing and Interpreting Data

SEP Element	Description of Elements in Grades 3-5
DATA-E1	Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.
DATA-E2	Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
DATA-E3	Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
DATA-E4	Analyze data to refine a problem statement or the design of a proposed object, tool, or process.
DATA-E5	Use data to evaluate and refine design solutions.

Grades 3-5 Progression for Analyzing and Interpreting Data

Unit	Support for Growth in Analyzing and Interpreting Data in Grades 3-5
3.1 Forces & Interactions	**Opportunity to Practice:** As they investigate different types of sculptures, students represent, analyze, and compare data collected by various groups to look for patterns that indicate cause-and-effect relationships (DATA-E1, DATA-E2, DATA-E3).
3.2 Weather & Hazards	**Intentionally Developed:** Students analyze and interpret data to make sense of weather and climate patterns in places that grow specific fruits (DATA-E2). They gather data about how plants make fruit and develop a shared graphical display to reveal relationships (DATA-E1). Students also work as a class to construct a bar graph of precipitation data to look for patterns, then they independently construct bar graphs of temperature data and compare them with peers to check for consistency (DATA-E1, DATA-E3). The class reads about and discusses many ways in which climate scientists represent data so that they can study different climates around the world (DATA-E1). These representations include bar graphs, but also tables and maps. Later, students combine information gathered by small groups about different weather-related hazards and organize the information in a chart so they can compare and contrast the data to identify similarities and differences in their findings (DATA-E3). When they are developing wind break designs, students use data from their tests to refine their designs, evaluate how well each solution meets the criteria and constraints, and consider how changes to their designs could better solve the problem of wind damaging fruit plants (DATA-E4, DATA-E5).
3.3 Trait Variations	**Intentionally Developed:** This unit explicitly supports students in analyzing and interpreting trait data and fossil evidence data, and students use this practice in almost every lesson of the unit. When working to make sense of trait variations, students organize data sets into bar graphs, tables, pictographs, and timelines, which reveal patterns that indicate relationships among families of animals and help them make sense of ideas about inheritance and how some trait variations help animals survive (DATA-E1, DATA-E2). Then students go on to analyze fossil data, using multiple timelines as well as bar graphs to make sense of what other animals and plants were living at the same time as humans, or before us. Students also analyze and interpret data from fossils, using logical reasoning about their knowledge of similar kinds of animals alive today and the environments where they live to make sense of what the environment was like long ago (DATA-E1, DATA-E2). The teacher and materials often explicitly support and scaffold this work, but students also have opportunities to analyze and interpret data more independently, especially at the ends of the second (trait data) and third (fossil data) lesson sets.
3.4 Ecosystem Change & Survival	**Intentionally Developed:** Students work with partners and as a class to analyze and interpret data from video and infographic cards using logical reasoning to make sense of seagrass similarities and differences. Then, they work with partners and individually to analyze patterns of seagrasses' appearance from direct observations and data tables of parent/offspring measurements using logical reasoning to make sense of how seagrasses inherit information from their parents (DATA-E2). Later, students represent a large data set in a table to reveal patterns that indicate relationships about why animals form groups (DATA-E1). Students also analyze data about proposed design solutions; they have more guidance from the teacher and

Unit	Support for Growth in Analyzing and Interpreting Data in Grades 3-5
	their small groups when considering warm water solutions, but later, they have more choice and independence for the task of comparing seagrass and boating solutions (DATA-E4).
4.1 Energy Transfer: Collisions	**Opportunity to Practice:** Students read a book about the different ways that scientists carry out investigations and use what they learned in the book to represent, analyze, interpret, and compare data in tables and line plots in several lessons of the unit (DATA-E1, DATA-E3).
4.2 Energy Transfer: Electricity	**Not Claimed**
4.3 Earth Processes	**Intentionally Developed:** Students work in small groups with weather data cards (including maps of the US) to figure out what natural event caused the changes to the road in Acadia National Park. They work as a class, in small groups, and in pairs to analyze and interpret more complex ocean depth maps, elevation maps, and world-wide maps of Earth's land and ocean features to make sense of where volcanoes are likely to occur. Then students work in pairs and individually to analyze and interpret world maps to find patterns and make sense of where other hazards, such as earthquakes, are likely to occur (DATA-E2). After students test their erosion-prevention design solutions in wave bins, they compare the data they collect in a gallery tour to evaluate the design solutions, informing a discussion about how each of the designs met the criteria and constraints (DATA-E4). Then they independently use data collected from design solution tests to evaluate three different proposed solutions to reduce erosion by wind at the Indiana Dunes National Park (DATA-E5).
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Opportunity to Practice:** Students practice analyzing and interpreting data represented in graphs and from their own investigations related to plant growth (DATA-E1). They build on this work when they use math and logical reasoning to analyze data about the weight of a termite colony over time (DATA-E2), and when they compare the differences in data collected by different groups about mushrooms (DATA-P3).
5.2 Matter Properties	**Not Claimed**
5.3 Earth Systems	**Opportunity to Practice:** Students use precipitation data to construct graphs in order to reveal patterns between times of heavier precipitation and greater water flow through the Elwha River system (DATA-E1). Students also analyze and interpret data from maps to make sense of how much salt water and fresh water is available on Earth (DATA-E2).
5.4 Sun, Moon, & Star Patterns	**Intentionally Developed:** Students track daily changes in shadow length and direction, then compare data across groups to identify patterns, which they then use to make sense of shadow data across an entire year (DATA-E2). Initially, students work with data tables to uncover trends such as shadow directionality; however, they also recognize the limitations of data tables for revealing more complex patterns. After reading a book about how scientists

Unit	Support for Growth in Analyzing and Interpreting Data in Grades 3-5
	represent data, students transition to using CODAP, an online graphing tool, to create line graphs of shadow data which allow them to identify additional trends (DATA-E1). Students go on to use angular measurements between the Moon, the observer, and the east cardinal direction to calculate daily changes in the Moon's position in the sky. Organizing this data in tables highlights that the Moon's position changes more each day than the Sun's (DATA-E1). Later, students analyze large data sets in tables and line graphs to determine patterns in day and night lengths across different locations. Students collaborate with small groups to create line graphs using CODAP, then individually analyze their graphs to construct arguments about whether different communities experience their longest nights on the same day (DATA-E1). When students conduct research to compare night sky objects across various characteristics and measurements, they apply what they figured out about representing data to create number lines which help them identify differences among the objects (DATA-E1, DATA-E3). Students also consider whether a data table or a number line will best help them make sense of star data at such an immense scale. Finally, students independently analyze and interpret data in bar graphs to reveal patterns in the locations and seasonal appearance of different constellations (DATA-E2).

Using Mathematics and Computational Thinking (MATH)

Grades K-2 Elements of Using Mathematics and Computational Thinking

SEP Element	Description of Elements in Grades K-2
MATH-P1	Decide when to use qualitative vs. quantitative data.
MATH-P2	Use counting and numbers to identify and describe patterns in the natural and designed world(s).
MATH-P3	Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
MATH-P4	Use quantitative data to compare two alternative solutions to a problem.

Grades K-2 Progression for Mathematics and Computational Thinking

Unit	Support for Growth in Using Mathematics and Computational Thinking in K-2
K.1 Energy: Sunlight	**Not Claimed**

Unit	Support for Growth in Using Mathematics and Computational Thinking in K-2
K.2 Weather	**Intentionally Developed:** Each time the students share their observations of a new weather condition, the teacher supports the class by tallying and helping count the different observations to guide the class to a consensus recording (pattern) they post on their Weather Calendar. In subsequent lessons, the students work in smaller groups to count their results to find consensus without the help of a tally chart (unless needed). Students also use counting and numbers to identify a cause-effect pattern in how rain gauges work. (MATH-P2) The class works together to compare the rain/snow observations they have collected over several days and display the data in a picture graph, then small groups of students work together to similarly use picture graphs to compare daily observations for other weather conditions. Later, the students take more responsibility for adding to each picture graph with a small group or partner. (MATH-P3)
K.3 Forces in Motion	**Opportunity to Practice:** Students collect and organize data using tally marks to describe patterns in how different strengths of pushes affect motion (MATH-P2). Students also count the number of pushes it takes to move the ball to the ending point in order to evaluate and improve their design solutions (part of MATH-P4).
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Opportunity to Practice:** The class uses quantitative attributes to describe the amount of light (some, none, all) that can pass through different materials and use the categories some, none, and all to display their data in a Floor Data chart display (MATH-P3).
1.2 Waves: Sound	**Not Claimed**
1.3 Space: Sky Patterns	**Intentionally Developed:** Students are supported across multiple lessons in using this practice with larger numbers and more complex comparisons than they encountered in kindergarten. They use counting and numbers to identify the lengths of daytime and nighttime in hours on a specified day and to identify the length of daytime on a day in a specific month (for all 12 months). Students are then able to describe seasonal patterns of daytime length (MATH-P2). Students display these quantitative attributes (the number of hours of daytime and nighttime and the number of hours of daytime in each of the 12 months of a year) using simple graphs, which they use to make comparisons among the data (MATH-P3). Over multiple lessons, students work as a class and with partners to develop this practice.
1.4 Animal & Plant Traits	**Opportunity to Practice:** Students use counting and numbers to identify and describe patterns in how plants and animals compare. Students work together to develop a data table and use tally marks to count similarities and differences between parents and offspring (MATH-P3). These counts help them describe patterns most plants and animals follow (MATH-P2).
2.1 Earth: Land Changing Shape	**Not Claimed**

Unit	Support for Growth in Using Mathematics and Computational Thinking in K-2
2.2 Structure & Properties of Matter	**Not Claimed**
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Intentionally Developed:** In this unit, a new element of the practice is introduced. While the terms qualitative and quantitative are not used at this grade level, students are introduced to the idea of 2 types of data when the class reads a book about planning investigations. Then, as students plan and carry out their plant investigations, they decide which type of data to collect (MATH-P1). They count and measure quantitative attributes, including plant height and number of leaves. Students display their data on line plots, using these to make comparisons between plants in different conditions (MATH-P3). Using data from every investigation group, displayed in line plots, students are able to identify patterns in their observations of different plants (effects) and connect these to the plants' different conditions (cause) (MATH-P2).

Grades 3-5 Elements of Using Mathematics and Computational Thinking

SEP Element	Description of Elements in Grades 3-5
MATH-E1	Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.
MATH-E2	Organize simple data sets to reveal patterns that suggest relationships.
MATH-E3	Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.
MATH-E4	Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.

Grades 3-5 Progression for Using Mathematics and Computational Thinking

Unit	Support for Growth in Using Mathematics and Computational Thinking in Grades 3-5
3.1 Forces & Interactions	**Not Claimed**
3.2 Weather & Hazards	**Opportunity to Practice:** Students organize simple data sets to reveal patterns in weather conditions for growing fruit trees in certain locations and at certain times of year, and they organize their windbreak design testing results into a data table to reveal patterns about which design elements worked best (MATH-E2).

Unit	Support for Growth in Using Mathematics and Computational Thinking in Grades 3-5
3.3 Trait Variations	**Opportunity to Practice:** Students organize simple data sets of trait variations in canines to reveal patterns that suggest those trait variations are shared among family members (MATH-E2). Students also organize historical images on a timeline to investigate people's relationships with dogs throughout history (MATH-E3).
3.4 Ecosystem Change & Survival	**Not Claimed**
4.1 Energy Transfer: Collisions	**Not Claimed**
4.2 Energy Transfer: Electricity	**Opportunity to Practice:** Students use their developing understanding of voltage to predict how many batteries will be needed to light an LED (MATH-E3), and decide if they should use qualitative and/or quantitative data to help them determine how well their communication devices meet the class criteria and constraints (MATH-E1).
4.3 Earth Processes	**Not Claimed**
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Not Claimed**
5.2 Matter Properties	**Opportunity to Practice:** Students measure the weight of the solar still before and after its use to determine if the solar still would work to remove material from their water samples (MATH-E3).
5.3 Earth Systems	**Intentionally Developed:** Students use graphs to reveal seasonal patterns in precipitation data and water flow to help answer their questions about where the water in the Elwha River system comes from (MATH-E2). Students work in groups and independently to estimate, describe, and graph quantities to address their scientific questions about the availability of freshwater and whether we would need to build dams to secure a reliable supply of it. Students estimate the amounts of freshwater they use for daily activities and engage in a discussion that motivates the need for the use of a standard unit of measurement, gallons. Students then make sense of the number of gallons of freshwater that are used to produce many common items. After quantifying these amounts, students are motivated to figure out how the use of large amounts of freshwater can impact specific locations (MATH-E3).
5.4 Sun, Moon, & Star Patterns	**Opportunity to Practice:** After tracking shadow lengths and directions, the class discusses how they can organize the data to reveal patterns that suggest relationships between the Sun's movement and daily shadow changes (MATH-E2). Students also use subtraction algorithms to determine the amount that the Sun and Moon appear to move during a 2-day period, and

Unit	Support for Growth in Using Mathematics and Computational Thinking in Grades 3-5
	make sense of the size differences between the Sun and other stars by describing the differences in quantitative ways (e.g., 7 times brighter) (MATH-E4). Students initially describe the differences in stars using qualitative terms, but are motivated towards quantitative descriptions to more accurately represent the scale differences between the Sun and other stars (MATH-E1).

Constructing Explanations and Designing Solutions (CEDS)

Grades K-2 Elements of Constructing Explanations and Designing Solutions

SEP Element	Description of Elements in Grades K-2
CEDS-P1	Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.
CEDS-P2	Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.
CEDS-P3	Generate and/or compare multiple solutions to a problem.

Grades K-2 Progression for Constructing Explanations and Designing Solutions

Unit	Support for Growth in Constructing Explanations and Designing Solutions in K-2
K.1 Energy: Sunlight	**Intentionally Developed:** This unit formally introduces the practice of designing solutions when students work as a class to brainstorm possible solutions to the problem of the blacktop being too hot in the sun. They go on to individually generate solutions and compare them with a partner's to make a combined design plan. Those pairs of students select materials provided by their teacher to build their designs. Then, after testing, they compare all of their solutions as a class to consider which design features and materials worked best to keep the blacktop less hot. Finally, the class uses the ideas generated from their comparisons to create a class consensus design. Throughout the unit, students are supported by whole group discussions, including reading a book about a playground designer's process, and opportunities to work with partners. The class generates and compares multiple solutions (CEDS-P3) that they designed and built to keep the blacktop less hot (CEDS-P2).
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Opportunity to Practice**: Students use evidence from investigations to explain how pushes and collisions affect motion (CEDS-P1) and apply what they figured out to design and build a game board that moves a ball to a goal (CEDS-P2). As they test, revise, and share their designs,

Unit	Support for Growth in Constructing Explanations and Designing Solutions in K-2
	students compare multiple solutions and explain how their design choices helped solve the problem (CEDS-P3).
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Intentionally Developed:** In kindergarten, students focused on designing solutions; now in first grade, they develop the practice of constructing explanations. In this unit, students make firsthand observations (carefully notice details) of what it is like to read under different covers and from investigations using a pinhole box. As the unit goes on, students are supported in constructing evidence-based accounts (including drawings, written words, spoken language, and gestures) for why light appears brighter or dimmer under certain materials and how light is required to see. The teacher guides the class in recording these accounts on their Our Growing Ideas chart. By the end of the unit, students use their observations from throughout the unit to construct an individual evidence-based account (in the form of an illustrated page in a class book) for how to read under covers when it is dark (CEDS-P1).
1.2 Waves: Sound	**Intentionally Developed:** This further develops students' use of the designing solutions part of this practice. Students design (draw and build) a sound signal device using available materials and simple tools in order to solve their engineering problem of needing a way to communicate a good news message across the classroom (CEDS-P2). Students generate initial drawn designs, compare these with a partner, and then generate a new solution incorporating features of both initial designs. Across several lessons, students continue to compare multiple solutions through small group and whole class opportunities, figuring out how there are always multiple possible solutions to an engineering problem (CEDS-P3). Students are supported in this work by whole class discussions, including when reading a book about an engineer who designs devices for the DeafBlind community, and by working with the same engineering partner for the entire lesson set.
1.3 Space: Sky Patterns	**Not Claimed**
1.4 Animal & Plant Traits	**Intentionally Developed:** In the first part of this unit, students make observations of plant and animal parts to use as evidence to construct a class explanation about how individuals of the same kind of plant or animal look compared to each other. Students also construct individual evidence-based explanations including both structures and behaviors to explain how plant and animal parts help them live and grow (CEDS-P1). In the second part of this unit, students generate multiple initial design ideas to solve human problems (related to movement, protection, or getting food) by mimicking how plants and animals use their parts. The class co-creates a Gotta-Have-It Checklist to clarify what their device needs to do, and students compare drawings of their solutions with a partner who is solving the same type of problem. Finally, students apply feedback and use materials to build their devices and compare them across the class, to notice how similar problems can be solved in multiple ways (CEDS-P2, CEDS-P3).

Unit	Support for Growth in Constructing Explanations and Designing Solutions in K-2
2.1 Earth: Land Changing Shape	**Intentionally Developed:** In second grade, students further develop this practice by using it in the context of new crosscutting concepts; in this unit, that is stability and change. Students begin the unit by constructing an initial explanation (in the form of a model) for why land is changing shape in small groups and as a class, suggesting possible causes. Then students make multiple firsthand observations of their land change bins as they investigate how wind and water move different types of land and the timescales over which those changes happen. Students also make observations from books, image sets, and examples from their community that they use to construct evidence-based accounts for how wind and water can change the shape of land both rapidly and slowly. (CEDS-P1) Later in the unit, students design solutions to a community land change problem, individually and with a partner. Students develop a physical model of those solutions and test them to determine their effectiveness while comparing their designs with others (CEDS-P3), then use those observations to explain which solution best solved the problem (CEDS-P1).
2.2 Structure & Properties of Matter	**Intentionally Developed:** In this unit, students develop this practice to figure out that matter can be broken into smaller pieces, put together into larger pieces, and/or change shapes. Students read a text about toys that come in sets (e.g., building blocks, trains, marble runs), which helps expand their thinking about the different ways that a set of materials can make a variety of larger objects. Students meet in small groups to explain how their toy is made of a set of smaller pieces and identify the different ways that the materials can be changed or used. As a class, students work to explain how objects can be disassembled and the pieces can be reassembled to make a new toy. Later in the unit, students make firsthand observations and watch videos of different materials, like a crayon and paper, being heated and cooled. These observations support students in individually explaining that some materials go through reversible changes when heated while others do not. (CEDS-P1)
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Not Claimed**

Grades 3-5 Elements of Constructing Explanations and Designing Solutions

SEP Element	Description of Elements in Grades 3-5
CEDS-E1	Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).
CEDS-E2	Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
CEDS-E3	Identify the evidence that supports particular points in an explanation.
CEDS-E4	Apply scientific ideas to solve design problems.

SEP Element	Description of Elements in Grades 3-5
CEDS-E5	Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Grades 3-5 Progression for Constructing Explanations and Designing Solutions

Unit	Support for Growth in Constructing Explanations and Designing Solutions in Grades 3-5
3.1 Forces & Interactions	**Opportunity to Practice:** Students construct an explanation using if/then statements to explain an observed cause-and-effect relationship between the amount of applied extra force to a sculpture and the resulting change in motion (CEDS-E1). Students also construct explanations of their sculpture designs and/or gameplay using ideas and evidence from their previous investigations (CEDS-E2). Finally, students use scientific ideas about the forces between magnets and other objects to design a solution to solve an everyday problem (CEDS-E4).
3.2 Weather & Hazards	**Intentionally Developed:** In this unit, students focus on generating and comparing multiple possible design solutions to protect plants from high winds. After researching the problem, students generate models to conceptually show how wind affects fruit plants and how three possible windbreak designs would protect the plants. Later, they work in small groups to build and test the different windbreaks, gathering data on how well the windbreaks worked. (CEDS-E5). Students also work in small groups to collect data from testing their design solutions in terms of the criteria and constraints they developed, and use evidence from testing to compare their design solutions (CEDS-E2). Students also independently make comparisons of possible solutions as part of an assessment task, using evidence to support a design solution that helps a farmer protect their apple orchard or fixes a schoolyard flooding problem. (CEDS-E2, CEDS-E5)
3.3 Trait Variations	**Intentionally Developed:** In this unit, students focus on constructing explanations (rather than developing solutions), beginning with whole-class initial explanations for why animals look and act the way they do based on observations of newborn and adult canines. As the unit goes on, students use evidence from their investigations to support explanations for how learning influences animals' behavioral traits, why people choose certain breeds of dogs for certain jobs, and how certain trait variations can provide an advantage to survival. Students construct oral and written explanations and draw explanatory models, explicitly supported by a checklist the class builds together and that students use independently in later lessons. (CEDS-E2). Students also have multiple opportunities to give and receive peer feedback about their explanations, identifying the evidence that supports particular points (CEDS-E3).
3.4 Ecosystem Change & Survival	**Opportunity to Practice:** Students compare multiple possible design solutions to protect manatees from habitat changes (CEDS-E5).
4.1 Energy Transfer:	**Intentionally Developed:** In this unit, students focus on constructing explanations; they work on designing solutions in Units 4.2 and 4.3. Here, students use evidence from their

Unit	Support for Growth in Constructing Explanations and Designing Solutions in Grades 3-5
Collisions	investigations to construct and support explanations about energy transfer. They use their measurement and observations of how different types of balls move from different sizes of kicks and on different surfaces to explain their changes in motion due to energy transfer (CEDS-E1, CEDS-E2). They also have opportunities to identify the evidence that supports particular points in an explanation (CEDS-E3). Across the unit, students develop oral explanations and models to explain as a class and in small groups. The class co-creates a Gotta-Have-It Checklist to support them in understanding what they should include in an explanation that describes how and why an object's motion changes, and students use that tool as they construct written explanations in small groups and individually.
4.2 Energy Transfer: Electricity	**Intentionally Developed:** Students build on their work from Unit 3.2 to design solutions for communicating information, such as the time, across their classroom. Students are supported by a book they read as a class about the engineering design process, and they generate design ideas they think will meet the class criteria and constraints. Students then translate those ideas into design solutions when they work in pairs and small groups to draw out their designs. Students test their time-communication devices and engage in a peer feedback activity that allows them to compare and contrast multiple solutions to determine how well they meet the criteria and constraints. (CEDS-E5) Students also have an opportunity to describe energy sources as either renewable or nonrenewable after observing relationships between the energy sources and their use by electricity-generating devices (CEDS-E1). At the end of the unit, students independently apply their understanding of the varying ways that energy can be transferred to refine a space rover, solving problems such as how it can move around and communicate information back and forth from Earth (CEDS-E4).
4.3 Earth Processes	**Intentionally Developed:** Students expand on their previous engineering work, especially from Unit 2.1, as they design solutions to erosion-related problems with the added challenge of designing and testing in their wave bins. They research how communities have solved erosion-related problems and generate multiple solutions to compare, supported by a book about how and why engineers compare solutions. They develop criteria and constraints to use to evaluate their solutions, then build and test their designs to mitigate coastal erosion. Their engineering design work is done with small groups and whole class discussions, and then at the end of the unit, students individually work to compare and evaluate solutions for a different erosion problem (CEDS-E5). Students also develop the practice of constructing explanations when they specifically focus on identifying evidence that supports an explanation. They work to do that first in small groups and then in pairs as they explain how the landscape of Hawaii has changed over time (CEDS-E3).
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Not Claimed**
5.2 Matter Properties	**Intentionally Developed:** In this unit, students use what they have figured out about ways to remove unhealthy materials from water to design solutions for community water problems.

Unit	Support for Growth in Constructing Explanations and Designing Solutions in Grades 3-5
	They read about several water problems and then generate and compare solutions for those problems, based on criteria and constraints they develop as a class. The class reads a book about how water treatment experts use science ideas to inform their engineering work. Students work in small groups to use peer feedback and gather and combine information from their previous work to make a design solution or combination of solutions for a specific community water problem (CEDS-E4, CEDS-E5). At the end of the unit, students also use evidence from a text to individually construct an explanation of how the water in a turtle's tank changed by adding a substance (CEDS-E2).
5.3 Earth Systems	**Opportunity to Practice:** Students apply ideas about how the spheres of the Earth interact to design solutions for improving freshwater access problems in multiple locations they have researched; they work with peers and individually across these lessons, using a comparison tool to consider how their potential solutions meet the criteria and constraints to have the least amount of impact on the Earth's spheres (CEDS-E4, CEDS-E5).
5.4 Sun, Moon, & Star Patterns	**Not Claimed**

Engaging in Argument from Evidence (ARG)

Grades K-2 Elements of Engaging in Argument from Evidence

SEP Element	Description of Elements in Grades K-2
ARG-P1	Identify arguments that are supported by evidence.
ARG-P2	Distinguish between explanations that account for all gathered evidence and those that do not.
ARG-P3	Analyze why some evidence is relevant to a scientific question and some is not.
ARG-P4	Distinguish between opinions and evidence in one's own explanations.
ARG-P5	Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell the main points of an argument.
ARG-P6	Construct an argument with evidence to support a claim.
ARG-P7	Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.

Grades K-2 Progression for Engaging in Argument from Evidence

Unit	Support for Growth in Engaging in Argument from Evidence in K-2
K.1 Energy: Sunlight	**Opportunity to Practice:** This unit introduces the routine, used in every K-2 unit, of synthesizing class ideas using Our Growing Ideas chart. At the end of each lesson, students make a claim (state what they figured out) and use evidence from their investigations (details about how they figured it out) to support their claim (ARG-P6). When students move to designing solutions to keep the blacktop less hot, they use the chart to track their claims about the effectiveness of their solutions, supported by evidence from their tests (ARG-P7).
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Not Claimed**
K.4 Plants, Animals, & Environments	**Intentionally Developed:** Students have multiple opportunities in this unit to use various elements of this practice, beginning when they make initial arguments to support a claim about whether birds, other animals, and plants need people to live, and they continue to use Our Growing Ideas chart to capture claims and evidence in each lesson (ARG-P6). Through class discussions, students have opportunities to identify arguments supported by evidence (ARG-P1) and consider explanations that account for some or all evidence (ARG-P2). They have several opportunities to listen actively to others' arguments to indicate agreement or disagreement based on evidence their classmates share about what plants and animals need to grow, and how animals change their environments to meet their needs (ARG-P5). The class reads a book together to explicitly support their use of this practice before students construct individual arguments to respond to the question of whether birds need help from people to live (ARG-P6).
1.1 Waves: Light	**Opportunity to Practice:** Students consider whether explanations for why it is brighter or dimmer under the covers account for all gathered evidence (a material being transparent, translucent, or opaque), while some explanations (a material being thin/thick) do not (ARG-P2).
1.2 Waves: Sound	**Not Claimed**
1.3 Space: Sky Patterns	**Intentionally Developed:** In this unit, students construct arguments with evidence to support claims related to patterns in the sky. Students make claims supported by evidence about the Sun's repeating locations in the sky, the Sun's location in the sky at a specific time of day, whether an event happens in the daytime or nighttime, and the season (summer, winter) in which a morning or evening event will occur (ARG-P6). As they engage in argumentation to reach a class consensus related to the Sun's repeating locations in the sky, students have opportunities to listen actively to indicate agreement or disagreement and to restate peers' claims and evidence. Students also listen actively to peers' arguments and indicate agreement or disagreement based on patterns (the Sun's apparent motion across the sky; seasonal patterns of daytime length and/or sunrise and sunset) as evidence (ARG-P5). Students also use a new element of the practice in this unit when they analyze multiple kinds of evidence to determine its relevance to questions about what makes it daytime or nighttime, determining that the Moon is

Unit	Support for Growth in Engaging in Argument from Evidence in K-2
	not relevant evidence because it is visible in both daytime and nighttime skies (ARG-P3). Over the course of the unit, students work as a whole class, with small groups, in pairs, and independently to gradually take on responsibility in their use of this practice.
1.4 Animal & Plant Traits	**Not Claimed**
2.1 Earth: Land Changing Shape	**Intentionally Developed:** In second grade, students focus on arguments about the effectiveness of their design solutions. They test their design solutions and share their observations about how much the land moved with partners, then with the class, to make claims about how well their design reduced the movement of the land. The class also reads a book together about how engineers test solutions and use test data to support claims about the effectiveness of their designs. Later, students individually select a design solution they believe was most effective at solving the problem and use relevant evidence (their observations) to support their claims (ARG-P7).
2.2 Structure & Properties of Matter	**Intentionally Developed:** At the beginning of this unit, students continue to construct arguments with evidence to support a claim as they investigate the properties of various materials (ARG-P6). Students use observations from simple tests as evidence to support claims about whether a material has a particular property (e.g., It is strong because it can hold 23 items.). Students also engage in argument when they work with a partner to reach a consensus as they organize materials on property charts, and then further discuss their decisions as a whole class. Later in the unit, students again work with a partner to make claims about whether a change to a material was reversible or irreversible and sort examples as evidence. In the second lesson set, students move to making claims about the effectiveness of the toys they are designing for kindergartners based on evidence (ARG-P7). The class reads and discusses a book about how engineers use argumentation to make decisions, and they individually update their toy designs and argue from evidence about a material that should be included. As they build their toys, students work with their partner to make claims about the materials they use based on the properties and function of the toy they are designing. Finally, students test the toys they built and provide and receive peer feedback with claims about how well the toy functions and evidence from test data to support their claim.
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Opportunity to Practice:** At a midpoint in the unit, students analyze evidence gathered across lessons to determine which is relevant to their scientific question about how a specific plant (the Tower Tree) started growing in a particular place (on top of the courthouse) (ARG-P3).

Grades 3-5 Elements of Engaging in Argument from Evidence

SEP Element	Description of Elements in Grades 3-5
ARG-E1	Compare and refine arguments based on an evaluation of the evidence presented.
ARG-E2	Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
ARG-E3	Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.
ARG-E4	Construct and/or support an argument with evidence, data, and/or a model.
ARG-E5	Use data to evaluate claims about cause and effect.
ARG-E6	Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

Grades 3-5 Progression for Engaging in Argument from Evidence

Unit	Support for Growth in Engaging in Argument from Evidence in Grades 3-5
3.1 Forces & Interactions	**Not Claimed**
3.2 Weather & Hazards	**Intentionally Developed:** Students begin by making initial claims for how they can get fruits all year. They investigate these ideas and practice making whole-class claims on Our Growing Ideas chart, which are supported with evidence gathered during the lessons. They write a claim based on evidence and give and receive feedback on that claim (ARG-E3). Later, they work as a whole class to write a full argument for how they can get fruits all year, including a claim supported by evidence and science ideas from Our Growing Ideas chart (ARG-E4). The class reads about how scientists construct arguments, then students practice writing their own arguments in a new context and get feedback from their teacher to help them improve their arguments (ARG-E3). Then students transition to making claims about design solutions that protect plants from damaging winds. They begin with initial claims for designs to protect plants. Through a series of investigations and testing, students revise their claims about design solutions, using criteria and constraints to guide their decision-making and supporting the claims with evidence (ARG-E4). As the unit progresses, students have opportunities to construct arguments with increasing independence, and at the end of the unit, students individually write an argument and support it with evidence and science ideas for how well their solutions meet criteria and constraints (ARG-E6).
3.3 Trait Variations	**Not Claimed**

Unit	Support for Growth in Engaging in Argument from Evidence in Grades 3-5
3.4 Ecosystem Change & Survival	**Intentionally Developed:** At the beginning of this unit, students develop two initial claims about why manatees and dolphins often share the same waters, and why a manatee joined a pod of dolphins. Throughout the unit, students gather evidence and refine their claims based on that evidence. Claim and evidence card sorts, graphic organizers, and Our Growing Ideas chart are key supports in this work. Later, students individually write a claim and use evidence to compose an argument about why orcas live in groups, and receive feedback from the teacher (ARG-E4). They also write an argument for why the manatee joined the dolphins, choosing the support they need, and using peer feedback to revise their ideas (ARG-E3, ARG-E4). In the second lesson set, the focus is on arguing for a design solution, supported by peer feedback and rounds of idea revision. Students make claims about design solutions for increasing seagrass availability, warm water access, and protection from boats for manatees. They support their claims with evidence from their investigations and research, and refine their arguments based on peer evaluation (ARG-E1, ARG-E3, ARG-E6).
4.1 Energy Transfer: Collisions	**Not Claimed**
4.2 Energy Transfer: Electricity	**Opportunity to Practice:** Students engage in argument from evidence when they make a claim about the merit of their design solution for communicating time and citing evidence for how well it meets the class criteria and constraints (ARG-E6). Students must also distinguish among facts and reasoned judgments when listening to their peers' presentations about the effects of usable energy sources (ARG-E2).
4.3 Earth Processes	**Not Claimed**
4.4 Structure & Function	**Intentionally Developed:** Students construct arguments supported by evidence in multiple lessons of this unit, as a whole class, with partners, and individually, with various scaffolds as they progress. At the beginning of the unit, they use evidence from their investigations to support claims about how animals and seeds can move through the air, and for the animals, how they land safely. Then they individually construct arguments about the relationship between the system of body structures that tree squirrels have and their ability to survive, grow, and build shelters. After that, students have opportunities to construct arguments in a different context, plant structures and functions (ARG-E4). Students also have multiple opportunities to give and receive peer feedback to improve their work, and engage in self-reflection on the practice (ARG-E3).
5.1 Ecosystems & Matter Cycling	**Intentionally Developed:** Students determine that the ideas they have been sharing about how to compare the weights of plants are a form of scientific argumentation, so they read a book to figure out more about how scientists use evidence to make claims about the natural world (ARG-E4). As the unit goes on, students have multiple additional opportunities to construct and evaluate arguments about how to measure matter and the factors that plants need to grow, working with classmates and individually (ARG-E1). Toward the end of the unit, students independently use their models to write an evidence-based claim about how matter is conserved in a nurse log system (ARG-E4).

Unit	Support for Growth in Engaging in Argument from Evidence in Grades 3-5
5.2 Matter Properties	**Not Claimed**
5.3 Earth Systems	**Opportunity to Practice:** Students support their claims with a model for what caused water in a community to flow to the place that it did, and explain how that model is supported by evidence from their investigations (ARG-E4). They also respectfully provide and receive critiques from peers about their proposed plans for solving a freshwater access problem (ARG-E3).
5.4 Sun, Moon, & Star Patterns	**Intentionally Developed:** Students work as a class to use evidence they collect from a physical model of Earth's rotation to support their argument that the Earth rotates in a counterclockwise direction. Students then work in small groups to use a physical model of the Moon's position as evidence supporting an argument for what day of the Moon's cycle an image was taken on. Working collaboratively, students construct arguments about the Sun's and Moon's changing positions in the sky. (ARG-E4) Groups then evaluate another group's argument for clarity, accuracy, and the relevance of evidence (ARG-E3). Students also individually construct an argument using data tables and line graphs to support a claim about patterns of day and night. Students analyze class-generated number lines to evaluate three claims about how to classify Jupiter, allowing teachers to revisit key aspects of constructing and supporting arguments. (ARG-E4) Students individually create their own arguments about how to classify the Sun, applying their evaluation skills to self-reflect and refine their reasoning. Using evidence collected earlier in the lesson, students revise one of the arguments to enhance its clarity and accuracy, then get peer feedback on their work (ARG-E1, ARG-E3). Finally, students individually construct evidence-based arguments about the seasonality of stars (ARG-E4).

Obtaining, Evaluating, and Communicating Information (INFO)

Grades K-2 Elements of Obtaining, Evaluating, and Communicating Information

SEP Element	Description of Elements in Grades K-2
INFO-P1	Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).
INFO-P2	Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.
INFO-P3	Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.

SEP Element	Description of Elements in Grades K-2
INFO-P4	Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Grades K-2 Progression for Obtaining, Evaluating, and Communicating Information

Unit	Support for Growth in Obtaining, Evaluating, and Communicating Information in K-2
K.1 Energy: Sunlight	**Opportunity to Practice:** Students participate in interactive read-alouds of various types of text throughout this unit to obtain scientific information. This supports them in determining patterns and finding evidence about the natural world and obtaining technical information about how other people use the same science and engineering practices to figure out the phenomenon of sunlight warming surfaces (INFO-P1).
K.2 Weather	**Intentionally Developed:** During this unit, the class engages in interactive read-alouds of two infographics, five books, and a card sort to obtain scientific and technical information (INFO-P1). The teacher supports students in identifying how features of each of these texts help them answer their questions (INFO-P3). The class discusses how the specific images in a book show how a thermometer works to help them observe the temperature (INFO-P2). Later, students individually use writing and drawings to create Community Service Announcements that communicate information they have figured out about their locality's typical weather, potential severe weather, and how to prepare for those weather conditions. Students' work to communicate this information is supported by ample work time over multiple lessons, structured writing/drawing space, opportunities to receive and take up peer and teacher feedback, and time to practice sharing aloud with a partner before sharing aloud with members of their community (INFO-P4).
K.3 Forces in Motion	**Opportunity to Practice:** Students participate in interactive read-alouds of various types of text throughout this unit to obtain scientific information that supports them in determining patterns about how objects move, and obtain technical information about how other people use the same science and engineering practices they are using to design and revise their game boards (INFO-P1).
K.4 Plants, Animals, & Environments	**Intentionally Developed:** Students participate in interactive read-alouds using different texts in every lesson of the unit, including books, infographics, and an informational website (INFO-P1). The teacher also supports students in identifying how different features of the website can help them answer their questions (INFO-P3). Students also use writing, drawing, and speaking to communicate a solution for how people can make it easier for plants and animals to meet their needs in their environment (reduce human impact) (INFO-P4). Students' work to communicate this information is supported by discussing examples of how scientists communicate ideas from the Meet the Expert book, structured writing/drawing space, opportunities to receive and take up peer and teacher feedback, and time to practice sharing aloud with a partner before sharing in a gallery tour (INFO-P4).

Unit	Support for Growth in Obtaining, Evaluating, and Communicating Information in K-2
1.1 Waves: Light	**Opportunity to Practice:** The class reads various types of texts throughout this unit to obtain scientific information (INFO-P1), and they describe how the images in one of the books (displaying the different interactions of transparent, translucent, and opaque materials with light) support ideas about how much light passes through each type of material (INFO-P2). Students also use models, drawings, and/or writing to communicate scientific ideas to a chosen audience when they share their class book (INFO-P4).
1.2 Waves: Sound	**Opportunity to Practice:** Students use grade-appropriate texts to obtain scientific information reinforcing patterns students notice in evidence from their investigations about how sound and materials interact (INFO-P1). Additionally, students communicate their design solutions with their peers when they present orally--using drawing, writing, and their built sound signal devices as resources--to explain how devices can be used to communicate a good news message across the classroom (INFO-P4).
1.3 Space: Sky Patterns	**Opportunity to Practice:** As a class, students read a grade-appropriate infographic to obtain scientific information to determine how seasonal differences in daytime length are a pattern that repeat every year, and they read multiple other books and an article to support what they figure out in the unit (INFO-P1).
1.4 Animal & Plant Traits	**Intentionally Developed:** This unit builds on how students used this practice in kindergarten by providing opportunities to interact with more complex (grade-appropriate) texts, still supported by explicit instruction and teacher guidance (INFO-P1). As a class, students read books to obtain information about animal and plant parts, and how the shapes of animals' external parts relate to their functions for survival and growth. They use this information to identify patterns. Students also obtain information from images and videos to compare parents and offspring and describe patterns in how they are alike and different, and how plant parts function in ways that help the plant live and grow. Additionally, students obtain information from videos and a website to identify patterns in how animals act to help offspring survive, working with a partner to gather and interpret information from media. Later in the unit, students obtain information from an interactive read-aloud about how engineers design human-made objects by mimicking how plants and animals use their parts. Students then obtain information more independently as they select from multiple books and websites to gather evidence about plant and animal parts and functions in the context of designing solutions to human problems (INFO-P1). When using the website, students learn how to navigate electronic menus to find the information they need (INFO-P3). Finally, students communicate information and design ideas using drawings, labels, spoken explanations, and built models, supported by structured work time and opportunities to give and receive peer feedback (INFO-P4).
2.1 Earth: Land Changing Shape	**Opportunity to Practice:** In addition to using multiple texts of various types throughout the unit, the class reads an infographic to obtain technical information about the structure and function of design solutions for slowing land changes (INFO-P1).
2.2 Structure & Properties of Matter	**Opportunity to Practice:** Students read grade-appropriate texts throughout the unit to obtain scientific and technical information, such as the properties that they may find useful to consider when selecting materials for their toys (INFO-P1). Students also communicate to kindergartners

Unit	Support for Growth in Obtaining, Evaluating, and Communicating Information in K-2
	about the toy they made, the scientific ideas that supported the design, and the process they followed to develop the toy (INFO-P4).
2.3 Habitats & Biodiversity	**Intentionally Developed:** This unit builds on how students used this practice in first grade by providing additional opportunities to obtain information from more complex (still grade-appropriate) texts and communicate in more advanced ways. Students begin working with a unit-specific website to obtain information about land in different areas. Then they continue to work with partners to obtain further information about water in different areas, and later obtain information about where different plants and animals live in the national parks (INFO-P1). Through these experiences, students are supported in making decisions around which website pages and content from those pages help answer their questions (INFO-P3). Students also use different texts and text features, including images, to obtain information about water and how water can be solid or liquid depending on temperature (INFO-P2). They use that information to inform their later communication about the land and water in different national parks (INFO-P4). Expanding on their initial website experiences, students work in pairs with less scaffolded support from the teacher to obtain further information through grade-appropriate texts and text features to find out about biodiversity in different areas (INFO-P3). They use that information to identify patterns in biodiversity across national parks in different regions of the United States Students engage in interactive read-alouds of grade-appropriate texts, including an infographic, a newspaper article, and informational texts to obtain additional information about science ideas in those lessons (INFO-P1). Finally, students communicate information about biodiversity within the national park they researched when they develop a video to share with classmates (INFO-P4).
2.4 Plants	**Opportunity to Practice:** Students practice obtaining scientific information through class read-alouds and shared use of infographics, which provide evidence for how the structures of seeds, pollen, and animals make it possible for seeds and pollen to be moved to new places. Additionally, students build on their Plants Investigation results by obtaining scientific information from a text to determine the pattern that all plants, in all places, depend on light and water. (INFO-P1)

Grades 3-5 Elements of Obtaining, Evaluating, and Communicating Information

SEP Element	Description of Elements in Grades 3-5
INFO-E1	Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.
INFO-E2	Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.
INFO-E3	Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.
INFO-E4	Obtain and combine information from books and/or other reliable media to explain phenomena

SEP Element	Description of Elements in Grades 3-5
	or solutions to a design problem.
INFO-E5	Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.

Grades 3-5 Progression for Obtaining, Evaluating, and Communicating Information

Unit	Support for Growth in Obtaining, Evaluating, and Communicating Information in 3-5
3.1 Forces & Interactions	**Opportunity to Practice:** The class reads various types of texts throughout this unit to obtain scientific information about how artists use forces, where magnets are used in our lives, and how scientists plan investigations (INFO-E1). Later in the unit, students communicate about their sculpture designs using science ideas from their investigations (INFO-E5).
3.2 Weather & Hazards	**Intentionally Developed:** Students work as a whole class and in small groups to gather information about the places fruit grows, obtaining information from a variety of texts and visual media to develop ideas about weather patterns and climate around the world (INFO-E1). Students also work together to combine information in written text with that contained in corresponding charts to obtain information about how scientists engage in arguments from evidence and how engineers design solutions (INFO-E3). Finally, students work in small groups to obtain information about weather-related hazards from news articles and research cards, which provide them with evidence to support their work designing solutions to the problem of wind damaging fruit trees (INFO-E4).
3.3 Trait Variations	**Opportunity to Practice:** The class reads various types of texts and engages with other reliable media throughout the unit to obtain scientific information about animals' trait variations (INFO-E1). Students also use drawings, writing, speaking, and listening to communicate information about animals' life cycles (INFO-E5).
3.4 Ecosystem Change & Survival	**Intentionally Developed:** Throughout the unit, students obtain and combine information from varied sources, such as books, infographics, research cards, articles, images, videos, and maps. Students gather the information either as a whole class or in small groups, using it to make sense of why manatees and dolphins often share the same waters and why a manatee might have joined a pod of dolphins (INFO-E1). Throughout the unit, this practice supports students as they engage in argument from evidence. Students work with partners and individually to combine information from multiple sources to support their claims about why manatees and dolphins often share the same waters and why a manatee might have joined a pod of dolphins (INFO-E2).
4.1 Energy Transfer: Collisions	**Opportunity to Practice:** The class reads various complex texts throughout this unit to obtain scientific and technical information, including to learn how to play marbles, to gather evidence of how scientists plan and carry out investigations, to figure out how surfaces affect the way soccer is played, and understand how sound and heat are produced in various types of collisions (INFO-E1).

Unit	Support for Growth in Obtaining, Evaluating, and Communicating Information in 3-5
4.2 Energy Transfer: Electricity	**Intentionally Developed:** This practice is developed as students use all five elements over the course of the unit. Students first obtain information as a whole class from a book about why power outages occur, and then connect that information to evidence they gathered in their investigation of electric circuits (INFO-E1). Then, students work as a class to gather and combine information from videos and text about generating electricity from wind (INFO-E4). After that, they work in small groups to explore other usable energy sources with infographics and a book (INFO-E3). Students obtain information from text about the engineering design process so that they can better understand how to design, test, refine, and optimize devices for communicating the time (INFO-E1). Students then work in small groups to obtain information from a variety of sources to figure out what digitized information is and how it is used to transfer information (energy) across long distances (INFO-E4). Students further explore usable energy sources to determine what might be the effects on the environment when they plug in their devices. After obtaining information, they present what they learned in small groups using slideshow presentations, allowing students to gain practice in sharing orally, in text, and with pictures (INFO-E5). In pairs, students combine information across the presentations from their peers, and use evidence and make a reasoned judgment about the environmental effects of using various energy sources (INFO-E2). Finally, students individually obtain information about a Mars rover and use that information to design a solution to a problem (INFO-E4).
4.3 Earth Processes	**Opportunity to Practice:** Students read a newspaper article in order to obtain scientific information about what we can figure out from fossils in rock layers and describe how that information is supported by evidence (INFO-E1), and they obtain information about land changes from a variety of sources throughout the unit: images, videos, books, infographic cards, and maps.
4.4 Structure & Function	**Opportunity to Practice:** The class obtains and combines information from a variety of texts about how animals move through the air, function in the dark, and raise their young, and about the structures of plants. Many of these texts include diagrams, tables, and charts that students make sense of to help them understand how animals' and plants' structures function to help them survive. (INFO-E3, INFO-E4)
5.1 Ecosystems & Matter Cycling	**Opportunity to Practice:** The class reads various types of texts throughout this unit to obtain scientific information, which they use as evidence as they figure out the components and relationships in ecosystems (INFO-E1). Students also combine information from those texts with information from reliable media like time-lapse videos of natural processes occurring over time to explain those changes (INFO-E4). Students create an evidence table based on evidence from prior investigations and then collaborate as a class to create a comparison chart about how isopods and birds get and use energy (INFO-E5).
5.2 Matter Properties	**Opportunity to Practice:** The class reads various types of texts throughout this unit to obtain scientific information about water problems, combining information from those texts to determine which water samples contain unhealthy matter and to support them in comparing solutions to those problems (INFO-E4).

Unit	Support for Growth in Obtaining, Evaluating, and Communicating Information in 3-5
5.3 Earth Systems	**Intentionally Developed:** Students read various types of grade-appropriate texts to obtain scientific information about the Elwha River system. Texts used in this unit include books, articles, infographics, interviews, and a website, and students interact with these texts in a variety of settings (e.g. read aloud, partner reading, and individually). They combine information from these texts to explain interactions in the Elwha River system (INFO-E4). About halfway through the unit, students share their models with classmates and then share their explanations with a trusted member of their community outside the classroom. These explanations are oral and supported with images created by the students (INFO-E5). Toward the end of the unit, students individually read texts and then summarize the information, using it to develop a model based on evidence that explains what the water-related problem at their location is (INFO-E1).
5.4 Sun, Moon, & Star Patterns	**Opportunity to Practice:** Students work in pairs to gather data from a website to investigate differences among various celestial objects, combining what they figure out with classmates to find similarities and differences among the objects they researched (INFO-E2).

Appendix D: CCC Progressions - A Detailed Look

In this Appendix, we consider each CCC and describe how students build the elements of the CCC across the program. We use the CCC elements as defined in NGSS Appendix G, and for ease of reference, we have used the codes from *The NSTA Atlas of the Three Dimensions* (Willard, 2020). The following tables present the elements of each CCC followed by a table showing the progression of the CCC across the grade bands, K-2 and 3-5.

Patterns (PAT)

Grades K-2 Elements of Patterns

CCC Element	Description of Element in Grades K-2
PAT-P1	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Grades K-2 Progression for Patterns

Unit	Support for Growth in Patterns in Grades K-2
K.1 Energy: Sunlight	**Intentionally Developed:** The word "pattern" is defined explicitly with students to help them talk about how they are observing the same thing over and over again, and most of their work identifying patterns happens during class discussions to scaffold development of this concept. After observing the same pattern in several instances, students describe the phenomenon of surfaces in sunny places usually feeling hot and surfaces in shady places usually feeling less hot. Students use this pattern as evidence when they explain that sunlight causes surfaces to feel hot. Students also use the pattern of shady places feeling less hot to inform the engineering designs they build to solve the problem of the blacktop getting too hot. (PAT-P1)
K.2 Weather	**Intentionally Developed:** Students use the concept and definition of pattern to help them make sense of the multiple points of data they collect from their observations of weather conditions. Students work as a class to look for patterns across many individual observations of daily weather conditions in order to determine their class consensus weather observations, which they record on their class Weather Calendar. In each of those lessons, the class adds another condition to observe, so they build independence as they repeatedly practice finding patterns across their class observations. Then, students work in small groups to organize their Weather Calendar data in picture graphs to find patterns in weather conditions over time. They use these patterns to describe what the weather is usually like, referring back to the patterns they identified in the picture graphs as evidence. (PAT-P1)
K.3 Forces in Motion	**Intentionally Developed:** In this unit, students explore patterns of how different strengths and directions of pushes, pulls, and collisions affect the motion of an object. Students work as a class

Unit	Support for Growth in Patterns in Grades K-2
	to analyze patterns in their own investigations using classroom objects and toy cars. They build on these experiences when they work with a partner to apply observed patterns of motion to engineer and refine a game board design that moves a ball from a starting point to an ending point. Students also work in pairs to observe patterns in how other students' game boards function (in the human-designed world), which supports them in comparing solutions and recognizing shared design features that lead to success. (PAT-P1)
K.4 Plants, Animals, & Environments	**Opportunity to Practice:** Students practice observing patterns of animal and plant needs from videos, cards, infographics, and direct observation across this unit, then use those patterns as evidence when explaining how birds meet their needs (PAT-P1).
1.1 Waves: Light	**Not Claimed**
1.2 Waves: Sound	**Opportunity to Practice:** Building on the definition of patterns in kindergarten, students in first grade observe the cause-and-effect pattern of movement (vibrations) causing sound and use this pattern to describe how all sounds are caused by vibrating objects/materials. Students use patterns as evidence to support claims about what happens when sounds are received (We hear them, and we sometimes see or feel something moving.). Students also identify patterns in the types of messages people send using sound signal devices (human-designed world) and use those patterns as evidence to describe how and why people communicate using these technologies. (PAT-P1)
1.3 Space: Sky Patterns	**Intentionally Developed:** Students continue to develop this concept in a new context when they observe and describe patterns in the sky. They observe the Sun's changing locations in the sky and apparent motion across the sky in a low-high-low path, and work as a class to use those patterns as evidence supporting claims about the Sun's predicted location in the sky at a certain time. Students also observe and describe the patterns of the Moon's changing locations and apparent motion in the sky, recognizing these to be the same as the Sun's. They also describe the patterns of the Sun, Moon, and stars as they relate to daytime and nighttime, using these patterns (specifically, that the Sun is in the daytime sky but not the nighttime sky and that stars can be seen in the nighttime sky but not the daytime sky) as the best evidence to support claims about daytime and nighttime. Additionally, students observe and describe the pattern that daytimes are longer in summer and shorter in winter and individually use these patterns of seasonal daytime length as evidence to support claims about whether a specific evening event happens in the summer or winter. (PAT-P1)
1.4 Animal & Plant Traits	**Intentionally Developed:** Students begin noticing during class discussions that individuals of the same kind of plant or animal share recognizable features while also observing differences. Next, students explicitly apply the word "pattern" as they describe similarities and differences across multiple plants and animals of the same kind. Students extend this work as they observe patterns in how parents and offspring compare, using images and videos with increasing independence. Later, students use the patterns that they have observed as evidence when constructing explanations about why young plants and animals are like, but not exactly like, their parents. Students continue using patterns as they compare the functions of plant and animal parts and individually identify patterns in how parent and offspring behaviors help offspring

Unit	Support for Growth in Patterns in Grades K-2
	survive. Finally, students bring together these earlier patterns as evidence to explain how plants and animals use their parts and behaviors to help them live and grow. (PAT-P1)
2.1 Earth: Land Changing Shape	**Opportunity to Practice:** Students identify patterns of land changing when they work as a class to construct the Community Examples chart. Students continue to add other observations through books, investigations, and comparisons with the examples on the chart. As the unit goes on, students make increasing numbers of observations (both firsthand and from media) and compare patterns in different temporal scales. (PAT-P1)
2.2 Structure & Properties of Matter	**Intentionally Developed:** Students build on their work (and definition) from prior grades to observe, describe, and use patterns in various materials, investigating them in more detailed and complex ways to make sense of their common and unique properties. Students sort materials by property using charts to organize their observations as a class (e.g., a picture of wood in the not flexible column on the flexibility chart, a picture of wood on the tan column for color, etc). Students work with their peers to use these charts to describe patterns of the materials' properties. Then, students individually use these patterns as evidence for material choices when they design their own toys, and revisit these patterns as evidence when they individually write an argument supporting a material choice for their toy. Finally, students work in partners and use these patterns to make material choices for the toy they are building for a kindergartner. (PAT-P1)
2.3 Habitats & Biodiversity	**Intentionally Developed:** Students build on and broaden their work from prior grades to observe patterns of where plants and animals live, using these patterns to describe the phenomenon of encountering different plants and animals in different places. As they investigate places, students observe patterns of land, the relative shape and size of bodies of water, and water type (solid or liquid). This work is supported by compiling class data onto charts for students to discuss what is similar and different across many observations of land features and water features. Students use the observed patterns as evidence to inform the development of maps (as models) of the relative size and shape of land and water (including type) in different national parks. Then students work with partners to observe and use patterns to describe the biodiversity of plants and animals in different places, including their schoolyard and in both land and water habitats of a national park. They use observed patterns in how the plants and animals are similar and different as evidence of biodiversity in these places. Finally, students individually share their research on the plants and animals in the national parks and observe a pattern of biodiversity across these places. (PAT-P1)
2.4 Plants	**Opportunity to Practice:** Students observe and describe patterns in the natural world when they identify how, over and over, seeds with certain structures (spikes) stick to surfaces with certain structures (strand-like), while those without these structures do not (PAT-P1).

Grades 3-5 Elements of Patterns

CCC Element	Description of Elements in Grades 3-5
PAT-E1	Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products. • In third and fourth grades, we use the versions of this element stated in the relevant PEs: Similarities and differences in patterns can be used to sort and classify natural phenomena (Units 3.2, 3.3, 3.4) / designed products (Units 3.1, 4.1). • Note that Unit 4.3's bundle contains PEs that use two versions of this element; for the sake of simplicity, we chose to use the full version of the element in Unit 4.3. • The fifth grade PEs/units use the full version.
PAT-E2	Patterns of change can be used to make predictions.
PAT-E3	Patterns can be used as evidence to support an explanation.

Grades 3-5 Progression for Patterns

Unit	Support for Growth in Patterns in Grades 3-5
3.1 Forces & Interactions	**Intentionally Developed:** To begin this unit, students leverage and build on their work in grades K-2 when they work as a class to sort and categorize sculptures and everyday objects, looking for patterns in balance and movement (PAT-E1). Later in the unit, students work in small groups to investigate patterns in motion changes that occur when their sculptures use differently shaped balance points.They compare data from fair tests to find patterns they can use to determine if a specific balance point is more likely to cause a predictable motion (PAT-E2). At the end of the unit, students use patterns as evidence to explain the relationship between the strength and distance between magnets, and to explain what kinds of metal objects are and are not pulled toward magnets (PAT-E3). Throughout the unit, students are supported in using this concept through guiding questions on handouts, class discussions, and co-constructed class charts. They work with increasing independence as the unit goes on.
3.2 Weather & Hazards	**Intentionally Developed:** Students use this concept in almost every lesson of the unit to help them make sense of the weather and climates that support various crop plants. They identify similarities and differences in patterns of fruits' water needs and precipitation and temperature data to sort out locations where certain plants are likely to grow well and to figure out plants' life cycles (PAT-E1). Students also use patterns of seasonal temperature and precipitation changes to predict which places may or may not grow particular fruits (PAT-E2). At several points in the unit, students use patterns as evidence to support their explanations of common stages in plant life cycles, and how we can get apples, oranges, and bananas throughout the school year (PAT-E3). Throughout the unit, students are supported in using this concept through guiding questions on handouts, class discussions, and co-constructed class charts. They work with increasing independence as the unit goes on.

Unit	Support for Growth in Patterns in Grades 3-5
3.3 Trait Variations	**Intentionally Developed:** In this unit, students use patterns in almost every lesson with increasing independence as the unit goes on. Students begin the unit by investigating the similarities and differences in patterns of behavior and ability to classify life cycle stages across different kinds of dogs and then other animals (PAT-E1). Then students individually use the patterns of change they figured out about animals' life cycles to make predictions about an unknown animal's life cycle (PAT-E2). After starting to notice patterns of traits and/or variations in traits, students explicitly investigate patterns in the trait variations of parents and offspring to support their explanations that behavioral and physical trait variations are inherited (PAT-E3). Finally, students also identify patterns in fossil evidence to explain what an environment was like long ago, as a whole class and then individually (PAT-E3).
3.4 Ecosystem Change & Survival	**Intentionally Developed:** Early in the unit, students use patterns they identify in videos and maps to support initial claims about where dolphins and manatees typically live (PAT-E3). Students also identify patterns of similarities and differences in seagrasses as evidence supporting the explanation that plants get information for trait variations from their parents (PAT-E3). Throughout the unit, students use similarities and differences in patterns to sort and classify natural phenomena: students classify types of water using patterns in the similarities and differences of aquatic habitats for dolphins, manatees, and other animals and plants. They use similarities and differences in patterns of seagrass trait variations to classify them as similar or different types. Students also look for similar reasons animals might live in groups and sort animals into categories of how often they live in groups: all the time, sometimes, or almost never. (PAT-E1) Throughout the unit, students are supported in using this concept through guiding questions on handouts, class discussions, and co-constructed class charts. They work with increasing independence as the unit goes on.
4.1 Energy Transfer: Collisions	**Opportunity to Practice:** Students use patterns as evidence to support explanations when they observe that pushing or exerting a force on something (colliding with an object) results in changes in motion and shape (PAT-E3). Students continue to investigate and explain patterns related to changes in motion, and use those patterns to make predictions about what they might see during an investigation (PAT-E2).
4.2 Energy Transfer: Electricity	**Intentionally Developed:** Students deepen their understanding of this concept when they use patterns to make sense of ideas in the context of how energy sources are used to generate electricity, and how patterns themselves can be used to transfer information. Students work in small groups and as a class to use patterns to figure out how electricity is generated from usable energy sources and to identify the path of energy transfer (from the renewable or nonrenewable resource to turbines to generators to power lines to our wall outlets and devices; except for solar panels) (PAT-E3). Then, students work with partners and as a class to use patterns of 1s and 0s to understand how digitized information is transferred across long distances (PAT-E1).
4.3 Earth Processes	**Intentionally Developed:** Students use patterns in almost every lesson of this unit. They begin by working as a class to identify patterns in the mechanisms (e.g., wind, waves, ground shaking) of their proposed causes for the changes to land in Acadia National Park. They work as a class to notice similarities and differences in patterns to: determine what event happened

Unit	Support for Growth in Patterns in Grades 3-5
	in Acadia to cause the damage, describe wave motion, analyze simple rates of land change, and classify potential design solutions (PAT-E1). Students work in small groups to use patterns of change (emergence of ocean floor and land features and occurrences of natural hazards around the world) to make predictions about which places are most likely to experience volcanic eruptions and other natural hazards (PAT-E2). Students also work with partners to use patterns to support their explanations for how land is changed over time by weathering and erosion and how fossils and rock layers show change over time (PAT-E3).
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Opportunity to Practice:** Students look for patterns in investigation and observational data to use as evidence supporting explanations for how plants, animals, and fungi get and use matter and energy to grow (PAT-E3).
5.2 Matter Properties	**Not Claimed**
5.3 Earth Systems	**Opportunity to Practice:** Students use patterns to develop their list of criteria and constraints for testing student-generated water scarcity solutions (PAT-E2).
5.4 Sun, Moon, & Star Patterns	**Intentionally Developed:** Students leverage experiences from Unit 1.3 to make sense of the sky when they explore and begin to explain those patterns in almost every lesson of this unit. They begin the unit working as a class to identify patterns in the apparent movement of the Sun, Moon, and stars across the sky, which motivate further investigations throughout the unit. Students work with partners to delve deeper into patterns revealed through graphical representations of shadow length and direction changes over the year. Similarly, students uncover patterns in the Moon's monthly cycle, attributed to its orbit, and use these patterns to develop a physical model that helps explain the Sun and Moon's relative positions during the cycle. Students also use observed patterns as evidence in an argument about the time it takes for the Moon to rise as the Sun sets after a simultaneous rise. (PAT-E3) Students analyze day-length data and construct line graphs to demonstrate the pattern that the longest and shortest days of the year occur on the same date for 3 communities. Students also draw constellations visible on their birthdates and compare their findings with classmates; patterns emerge as students observe similarities in constellations among peers with close birthdates and fewer similarities with those whose birthdates are farther apart. Finally, students analyze a bar graph indicating that northern sky constellations are visible year-round, while southern sky constellations are seasonal. (PAT-E1) Throughout the unit, students use patterns they have previously identified to make predictions about shadow position and length, the Moon's rise and set times, and where an always-visible constellation would appear in the sky (PAT-E2).

Cause and Effect (CE)

Grades K-2 Elements of Cause and Effect

CCC Element	Description of Elements in Grades K-2
CE-P1	Events have causes that generate observable patterns.
CE-P2	Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Grades K-2 Progression for Cause and Effect

Unit	Support for Growth in Cause and Effect in Grades K-2
K.1 Energy: Sunlight	**Intentionally Developed:** Students begin this unit by observing patterns in how different surfaces feel in sunny and shady places around their schoolyard. Later, students make the connection between the patterns they observe and the cause of those patterns, and celebrate having answered their question about why some surfaces feel hot and others feel less hot. The words "cause" and "effect" are explicitly defined with students to help them explain what they figured out about why something happens. Students do a card sort using patterns they know from their experiences, including examples collected from their homes and community, to help them identify other cause-and-effect relationships around them. Then, students use their understanding of the cause-effect relationship between sunlight and warmer surfaces to design structures that will generate the observable pattern of a surface (the blacktop) feeling less hot if the Sun is not shining on it. Finally, when they test their designs, students find additional evidence of events causing observable patterns: blocking the sun from shining on a surface causes that surface to be less hot. (CE-P1) Throughout the unit, students work with varying levels of support, from whole-class instruction and discussions to partner work to individual explanations of causes and effects.
K.2 Weather	**Intentionally Developed:** Students work as a class to observe and discuss patterns in how the various weather conditions they investigate cause them (and others) to prepare to be comfortable outside. Students also use cause-effect thinking to notice patterns in how rain gauges and wind gauges help them observe the weather (more rain causes an increase on the rain gauge, and more wind causes the wind gauges to move more). Students then notice how different types of severe weather cause patterns in how people prepare for different severe weather. Finally, students individually create and share Community Service Announcements to communicate how different kinds of weather, including severe weather events, usually cause people to prepare and respond. Throughout this unit, students' identification of cause-and-effect relationships and the observable patterns they generate is heavily scaffolded by specific handout structures, teacher prompts, and class discussions. (CE-P1)
K.3 Forces in Motion	**Intentionally Developed:** Throughout this unit, students investigate how different strengths and directions of pushes and collisions influence an object's motion. Students observe the pattern that pushing causes objects to move away and pulling causes them to move closer. As

Unit	Support for Growth in Cause and Effect in Grades K-2
	students carry out investigations with partners and small groups, they work as a class to explain how the changes in speed and direction cause observable patterns in how objects move. (CE-P1) Students then experience a new element of this concept when they apply their understanding of cause and effect to test and revise their game board designs. Supported by class discussions, they work in pairs to use evidence from their tests to support or refute their ideas about what causes the ball to successfully move from the starting point to the ending point. (CE-P2)
K.4 Plants, Animals, & Environments	**Intentionally Developed:** Students develop this concept in a new context when they identify the effects of people's actions when people change the environment to get natural resources. Students determine that the effects of people's actions and their impacts on the environment is an observable pattern. Students obtain further information to expand their understanding of human actions as causes when they research choices that people can make to reduce their impact (solutions). They consider how these choices also impact the environment, but in potentially more positive/less negative ways for the environment, plants, and/or other animals. Students figure out that the different choices people make to reduce their impact can lead to an observable pattern that doing so can make it easier for some animals and/or plants to live and grow. This work is supported through guided discussion prompts related to cause and effect and scaffolded handouts with structured drawing/writing spaces. (CE-P1)
1.1 Waves: Light	**Intentionally Developed:** Students build on ideas they bring from kindergarten when they use cause-and-effect thinking to make sense of why it is easier to read in some places/situations than others. The class explicitly discusses causes and effects when they read an informational text about light in their communities; students read about how turning on a flashlight caused a space to become brighter. The students then turn the classroom lights on and off to determine the effects together. Throughout the unit, students have opportunities to design and use simple tests (shining light on different materials and observing objects in different lighting conditions) in small groups and eventually partnerships to gather evidence to support and refute their ideas about what causes a space to be bright or dim and what causes it to be easier or harder to see. Through these investigations, students identify patterns caused by a) light sources illuminating spaces, b) materials causing certain amounts of light to come through, and c) light being what causes us to see objects. Tests shining light on different materials allow students to gather evidence to refute ideas that characteristics of a material like its thickness or color alone caused a certain amount of light to pass through. They figure out the pattern that the material causes some, none, or all light to pass through, making the space beyond the material appear to be bright or dim. (CE-P1, CE-P2)
1.2 Waves: Sound	**Intentionally Developed:** At the beginning of this unit, students work as a class to identify a tentative cause-and-effect relationship between movement (vibration) and sound through observations of handbells and triangles. They continue to work in small groups to investigate other objects, testing them making sound and not making sound to gather additional evidence that can support or refute their ideas about causes. Students also use simple tests to gather evidence supporting ideas about causes within the context of engineering their sound signal devices. Students' many experiences throughout the unit enable them to notice observable patterns: sounds (effect) are caused by vibrations and vibrations (effect) can be caused by sounds. Students use these cause-and-effect relationships to individually explain unit

Unit	Support for Growth in Cause and Effect in Grades K-2
	phenomena (e.g., the clocktower) and work in pairs to solve engineering problems (sending a good news message across the classroom). (CE-P1, CE-P2)
1.3 Space: Sky Patterns	**Opportunity to Practice:** Students identify earlier sunrises and later sunsets as the cause for longer daytimes in summer (effect) while later sunrises and earlier sunsets cause shorter daytimes in winter (effect). They use these causes to describe the observable seasonal pattern of longer and shorter daytimes across a year. (CE-P1)
1.4 Animal & Plant Traits	**Not Claimed**
2.1 Earth: Land Changing Shape	**Opportunity to Practice:** Students practice identifying causes that generate observable patterns as they make connections between their investigations, the Community Examples chart, and books to identify that land is changing shape as a result of wind and water (CE-P1).
2.2 Structure & Properties of Matter	**Intentionally Developed**: In this unit, students deepen their understanding of cause-and-effect relationships when they explicitly name observable patterns that some effects (changes caused by heating and/or cooling) are reversible, and others are irreversible. Students read a book as a class and discover that some materials (like plastic and metal) change when heated, and the properties of the material seem to be the same when it cools. Next, students work as a class to observe a crayon and paper exposed to heat, and read about materials like clay and fabric, and figure out that heating these materials causes a change that is not reversible. Students also work with partners to sort additional example cards using the patterns they have established so far to provide more evidence that heating some materials causes changes that are reversible and while heating other materials causes changes that are irreversible. They individually argue from evidence about whether changes to glue were reversible or irreversible. (CE-P1) Then, in the second lesson set, students work with partners to use simple tests to determine if an object or material will cause a toy to work in a certain way. As student pairs test the toys, they gather evidence to determine if the properties of the materials (cause) they have selected allow the toy to function (effect) as it was intended (CE-P2).
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Intentionally Developed:** Students continue their development of this concept when they use evidence from their investigations to support causal connections between observable patterns in plants' growth and health (effects) and the plants receiving or not receiving light and/or water (cause). Students first engage with cause-and-effect reasoning informally, as they consider what they think plants need (light, water) and collaboratively plan an investigation to gather evidence that will address their scientific question. Then, across multiple lessons, students work in small groups to make observations and measurements that they can use as evidence. At first, these data support students' tentative causal connections as they observe and discuss similarities and differences in plants in different conditions. At the end of the investigation, students organize data from every investigation group and are able to identify patterns, including that plants receiving light and water grow more (height, number of leaves) and are healthier (green in color,

Unit	Support for Growth in Cause and Effect in Grades K-2
	other appearances) than those not receiving light and water. Students name these observable patterns as effects and connect them to their cause, finally explaining them independently using a model. (CE-P1)

Grades 3-5 Elements of Cause and Effect

CCC Element	Description of Elements in Grades 3-5
CE-E1	Cause-and-effect relationships are routinely identified, tested, and used to explain change.
CE-E2	Events that occur together with regularity might or might not be a cause-and-effect relationship.

Grades 3-5 Progression for Cause and Effect

Unit	Support for Growth in Cause and Effect in Grades 3-5
3.1 Forces & Interactions	**Intentionally Developed:** In every lesson of this unit, students identify, test, and/or use cause-and-effect relationships to explain how sculptures work or why they might not work. At the beginning of the unit, cause-and-effect question starters support students in forming their initial questions. Throughout the unit, students work with partners to build sculptures using a variety of materials and positions to explore and explain what causes a sculpture to balance or move in certain ways. They also ask cause-and-effect questions to plan their investigations and track their results using scaffolds that help them record if/then relationships as they change one variable at a time. Students use if/then statements, first as a class, and then with more independence, to explain the cause-and-effect relationships they identified through testing. (CE-E1)
3.2 Weather & Hazards	**Intentionally Developed:** Students research a problem (hazardous weather) that is causing damage to fruit plants. They work as a class to figure out that there are patterns in where certain hazardous weather occurs, but also a common pattern of high winds that happens in most hazardous weather. Students use this cause-and-effect relationship between high wind and damage to fruit plants to design windbreaks in small groups that can disrupt the negative effects. Students test the role of windbreaks and use the evidence they collect in their tests to argue for how the fruit trees are protected by the windbreak. Class discussions, structured handouts, and peer feedback opportunities all support students in identifying, testing, and using cause-and-effect relationships to explain wind damage to crops and how to prevent it. (CE-E1)
3.3 Trait Variations	**Intentionally Developed:** Students raise initial ideas about cause-and-effect relationships at the beginning of this unit when they suggest possible explanations for why newborn canines look and act the way they do. Over the course of the unit, with varying levels of support, students go on to identify cause-and-effect relationships about trait inheritance and use them to explain why canines and other animals look and act the way they do (change). They also

Unit	Support for Growth in Cause and Effect in Grades 3-5
	work in partners and as a class to figure out that trait variations among wild animals can cause them to have an advantage in surviving (changes in survival rates). They later use that cause-and-effect relationship to individually explain why the timing of a fur color change could influence an animal's ability to find food or hide from predators (change). (CE-E1)
3.4 Ecosystem Change & Survival	**Intentionally Developed:** Across this unit, cause-and-effect thinking is used to generate questions, summarize what we figured out, and support claims about why a manatee joined a group of dolphins. Students work as a class using a key anchor chart to identify and use cause-and-effect relationships to explain why designs for protecting manatees work. (CE-E1) Also in this unit, students have their first opportunity to consider that events that occur together with regularity might or might not be a cause-and-effect relationship. They work in small groups to make observations about manatees changing locations between coastal waters versus rivers or springs in different months of the year, and then work as a class to make sense of evidence that would support whether those changes in location through the year are a cause-and-effect relationship (CE-E2). At the end of the unit, students independently make a claim about the merit of a solution to the human-caused problem of sea turtles getting lost on their way to the ocean.
4.1 Energy Transfer: Collisions	**Intentionally Developed:** Students begin this unit by wondering about the causes of changes in motion they observe, and they continue to identify, test, and use cause-and-effect relationships to explain changes in motion in almost every lesson. Building directly off work they did in Unit 3.1, students ask cause-and-effect questions and make predictions using "if…then…because" statements that address questions guiding their fair test investigations, this time related to ideas about energy transfer. They plan these investigations and explain the results with increasing independence across the unit, and by the end, students can independently identify and explain several observable effects that are caused by energy transfer (CE-E1).
4.2 Energy Transfer: Electricity	**Intentionally Developed:** Students' use of cause-and-effect thinking in this unit begins when they identify possible cause-and-effect relationships that make a plug-in clock turn on and stay on. Students further explore these relationships as they make observations to gather more evidence about what makes a plug-in clock and a winding clock turn on and stay on. Then, students make the connections that electrical current that flows through wires (energy transfer) causes the plug-in clock to turn on and stay on (effect). Continuing their work to understand cause-and-effect relationships related to energy transfer, students gather evidence about what causes a wind turbine to be able to generate electricity, recognizing that multiple points of energy transfer allow electricity to reach devices from wind turbines. Finally, students will then use a cause-and-effect lens to grapple with the effects of usable energy sources on the environment and use their understanding of energy transfer and cause-and-effect relationships to trace how plugging in a device can cause effects on the environment. Since it is expected to follow Unit 4.1 in the recommended sequence, Unit 4.2 provides students with even more small-group and individual opportunities to identify, test, and use cause-and-effect relationships to explain changes due to energy transfer than Unit 4.1 does. (CE-E1)

Unit	Support for Growth in Cause and Effect in Grades 3-5
4.3 Earth Processes	**Intentionally Developed:** This unit provides students with multiple situations in which to identify, test, and use cause-and-effect relationships. First, students access their prior knowledge to consider what could have caused damage to a road. As they work in small groups to investigate possible causes, students identify and test the cause-and-effect relationship between the location and size of waves and the movement of objects in those waves. Students also work with partners to use a cause-and-effect relationship to support their explanation of how increased rainfall causes increased plant growth in Hawaii. Later in the unit, students expand their cause-and-effect thinking to make sense of additional examples of land changes in their own community, and apply it to designing solutions to erosion-related hazards. Students predict cause-and-effect relationships related to erosion and then test them in small groups. Finally, students independently consider how wind and water cause changes to land and use that thinking to choose a solution to reduce the effects of wind on the dunes. (CE-E1)
4.4 Structure & Function	**Opportunity to Practice:** Students investigate the cause-and-effect relationship between the amount of light shining on an object and the amount of that object that can be seen, then use that relationship to develop a model to explain what causes a flying squirrel to be able to see objects in low amounts of light (CE-E1).
5.1 Ecosystems & Matter Cycling	**Not Claimed**
5.2 Matter Properties	**Intentionally Developed:** Students explore the cause-and-effect relationship of filtering and its effect on water when they attempt to identify what in the water samples may be causing them to be unhealthy. Students work in small groups to investigate the properties of water samples to identify different materials. If present, the material causes certain things to be observed, indicating a relationship between the observed property of the water and material. Students predict the cause-and-effect relationship between elements of their filter design (cause) and the water sample after filtration (effect). Later, students continue to work in small groups to identify how parts of their filter design cause, or predict how they could cause, specific effects. This work is supported by a whole class read-aloud and discussion of how scientists and engineers use different treatment solutions to cause desired effects on water. Students make and revisit predictions about the cause-and-effect relationships of adding a substance to their water samples. Finally, students individually construct an evidence-based explanation that connects each piece of evidence to ideas they figured out via cause-and-effect relationships. (CE-E1)
5.3 Earth Systems	**Intentionally Developed:** In this unit, students further develop their use of this concept by exploring cause-and-effect relationships on a larger systems scale than they have in previous units when they explore the relationship between the addition of the dams on the Elwha River and the effects of those dams on the interactions of all of Earth's spheres. Students work as a class to consider the relationship between local human decisions (e.g., installing and then removing dams in the river) and the changes they cause to the hydrosphere, biosphere, and geosphere. Later, students work in small group to use this crosscutting concept to support

Unit	Support for Growth in Cause and Effect in Grades 3-5
	their design ideas to solve community water problems; they use cause-and-effect relationships to explain the changes that they anticipate happening at the location that they have been researching once the solution that they have planned is used. Finally, they independently apply this concept when developing a model to explain how a solution causes improvements to a water problem. (CE-E1)
5.4 Sun, Moon, & Star Patterns	**Opportunity to Practice:** Students examine how the Moon's orbit, Earth's rotation, and Earth's orbit cause observable patterns of apparent motion as seen from Earth. Investigations allow students to connect celestial movements to specific effects, such as changes in the Moon's position in the sky, the Sun's path across the sky, and seasonal variations in stars, fostering a deeper comprehension of the mechanisms behind these phenomena (CE-E1). Students also have the opportunity to wrestle with the question of whether relationships within data indicate a causal relationship or not: after noticing a possible relationship between distance and brightness of stars, students are asked to consider whether they have any evidence to support that causal relationship, which motivates further testing to confirm (CE-E2).

Scale Proportion and Quantity (SPQ)

Grades K-2 Elements of Scale, Proportion, and Quantity

CCC Element	Description of Elements in Grades K-2
SPQ-P1	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower).
SPQ-P2	Standard units are used to measure length.

Grades K-2 Progression for Scale, Proportion, and Quantity

Unit	Support for Growth in Scale, Proportion, and Quantity in Grades K-2
K.1 Energy: Sunlight	**Opportunity to Practice:** Students practice using the relative scale of "hot" or "less hot" to compare surfaces they investigate throughout the unit, and they use the relative scale of bigger and smaller to consider how their engineering designs compare to the actual blacktop (SPQ-P1).
K.2 Weather	**Opportunity to Practice:** As students collect, record, and discuss their observations of local weather, they make relative comparisons related to the wind condition outside (light/moderate/strong) and movement of the wind gauge arm (higher/lower), when using thermometers to measure temperature (higher/lower, warmer/colder), when describing cloud conditions (more/less), and when using rain gauges to measure rain/snow (higher/lower) (SPQ-P1).

Unit	Support for Growth in Scale, Proportion, and Quantity in Grades K-2
K.3 Forces in Motion	**Opportunity to Practice:** Students use relative scales to compare the effects of different-strength pushes (small or big) on motion, and describe the resulting speed (fast or slow) and distance (near and far). These scales allow students to compare and describe the causes and effects of changes in motion during their investigations of toy cars and marbles. (SPQ-P1)
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Not Claimed**
1.2 Waves: Sound	**Not Claimed**
1.3 Space: Sky Patterns	**Opportunity to Practice:** Students use relative scales when they describe the changing locations of the Sun and Moon in the sky using relative time (early or late). Students also use relative scales to compare the length of daytimes (shorter or longer) and number of daytime hours (more or less) as they describe these seasonal patterns. (SPQ-P1)
1.4 Animal & Plant Traits	**Opportunity to Practice:** Students use the relative scale of bigger and smaller to observe and describe similarities and differences between plants and animals of the same kind, and they continue to use this language to describe and compare plant and animal parents and offspring (SPQ-P1).
2.1 Earth: Land Changing Shape	**Opportunity to Practice:** Students use relative terms to describe the timescale over which land changing shape can occur (slowly or quickly), and the relative scale of “a lot” or “a little” to describe how much land moves during their investigations (SPQ-P1).
2.2 Structure & Properties of Matter	**Not Claimed**
2.3 Habitats & Biodiversity	**Intentionally Developed:** Students have opportunities to use this concept in almost every lesson of the unit, including for multiple assessments. They work as a class to compare relative sizes (bigger, smaller), features (taller, flatter), and temperatures (hotter, colder) when observing land and water. Later, students use relative scale with more independence when comparing land and water on different maps and then developing their own physical map of the land and water in an area of a national park. Finally, students use relative scale to describe and compare plants when sorting them into groups (short ground, medium-sized, high-reaching). Across the unit, students work with the whole class, small groups, and partners to apply this concept (PSPQ-P1).
2.4 Plants	**Opportunity to Practice:** Students use units (centimeters) to measure the height (length) of plants throughout their multi-lesson Plants Investigation (SPQ-P2). (Note that students do not use this element of the concept earlier in the program because standard units of measure are

Unit	Support for Growth in Scale, Proportion, and Quantity in Grades K-2
	not introduced in CCSS Math until second grade, and they will have multiple additional opportunities to measure using standard units in grades 3-5.)

Grades 3-5 Elements of Scale, Proportion, and Quantity

CCC Element	Description of Elements in Grades 3-5
SPQ-E1	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.
SPQ-E2	Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Grades 3-5 Progression for Scale, Proportion, and Quantity

Unit	Support for Growth in Scale, Proportion, and Quantity in Grades 3-5
3.1 Forces & Interactions	**Opportunity to Practice:** Students use standard units of measurement for distance (using a ruler in centimeters or inches) and weight (using a digital scale, in whole grams) (SPQ-E2).
3.2 Weather & Hazards	**Opportunity to Practice:** Students use standard units of measurement for precipitation (inches) and temperature (degrees Fahrenheit) (SPQ-E2). They also consider the time scale being represented by temperature and precipitation data to develop an understanding that climate is the long-term pattern of temperature and precipitation in a place (SPQ-E1).
3.3 Trait Variations	**Intentionally Developed:** Scale is critical to students' sensemaking as they make sense of fossil evidence in relation to animals and places today and those long ago. Multiple lessons use scaled timeline representations, which the class co-constructs with counting cubes, images, string, and other physical markers, to support students in understanding the immense scale of time for fossil records compared to the scale of time for their own personal history. Finally students independently apply this concept when analyzing and interpreting fossil data on a summative assessment task. (SPQ-E1)
3.4 Ecosystem Change & Survival	**Not Claimed**
4.1 Energy Transfer: Collisions	**Opportunity to Practice:** Students frequently use this crosscutting concept when they use standard units to measure the distance a ball moves (centimeters or inches) and the temperature of objects (degrees Fahrenheit) (SPQ-E2).
4.2 Energy Transfer: Electricity	**Not Claimed**

Unit	Support for Growth in Scale, Proportion, and Quantity in Grades 3-5
4.3 Earth Processes	**Opportunity to Practice:** Students practice using this crosscutting concept when they consider the relative time it could take for ocean waves to erode rock. Students share initial ideas that some changes to the land could take long periods of time, and some changes to land happen in a very short amount of time (SPQ-E1).
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Intentionally Developed:** Students use this concept multiple times throughout this unit, and have significant teacher support especially as they consider particles that are too small to see. Throughout the unit and with varying levels of independence, students develop the idea of scale through modeling, creating zoom-ins to show the scale of various components of the nurse log system. For example, students model to explain how microscopic organisms within a termite gut break down bits of wood, and they model to explain how water and other particles move through a plant system. Students also consider and then watch how time-lapse videos help us to observe the relatively slow processes (compared to time we have in class) of plants growing and decomposers breaking down matter in a system. (SPQ-E1) Students also have several opportunities to use standard units of measure as they compare the weight of pumpkins, other plants, air, and water (SPQ-E2).
5.2 Matter Properties	**Intentionally Developed:** Students rely on this concept to help them identify in their investigation plan how they will measure how much of the matter is removed by their filter. They work in small groups to measure the weight/mass of their water samples using a scale in grams (and optionally: volume) to describe how the water sample changed before and after filtering. Students work in small groups and as a class to consider the scale of the materials in their water samples when they determine that vinegar, iron, baking soda, and chlorine are present in some of the samples even though their particles are too small to be seen. Students use the weight data they recorded to make sense of the idea that even though other properties of their mixture changed, the weight stayed the same. Finally, students work in small groups to describe physical quantities such as weight, time, temperature, and volume when discussing solutions to community water problems, and whether the solutions they test in the classroom would also work at scale large enough for a whole community. (SPQ-E1, SPQ-E2)
5.3 Earth Systems	**Intentionally Developed:** Near the beginning of this unit, students use inches and gallons to make sense of precipitation and water flow data as they consider where the water in the river comes from and goes to. Later, as students investigate the amount of freshwater available on Earth, they use cubic miles and milliliters to compare amounts. Finally, the class has an explicit discussion about the need for a standard unit of measure when they want to compare the amounts of water we humans use in daily activities as well as manufacturing; the class decides to use gallons to compare measurements in that investigation. As the unit progresses, students use this concept in increasingly complex ways, so this work is done with support from classmates and the teacher (in small groups and as a whole class). (SPQ-E2)
5.4 Sun, Moon, & Star Patterns	**Intentionally Developed:** Students' work with this concept is larger and more complex than in previous grade levels. They begin similarly to other units: reporting shadow data collected

Unit	Support for Growth in Scale, Proportion, and Quantity in Grades 3-5
	using slightly different experimental setups requires them to consider the importance of standard units (e.g. centimeters) in order to build consensus during a class discussion of their findings. Later, students work as a class and with partners to use a standard unit of measure (degrees of angles) and compare the locations the Moon and Sun appear to reach in the sky daily. Students can build on the work they did with immense scales in Unit 3.3 when they work in small groups to use number lines to organize and make sense of data using multiple standard units, including astronomical units (AU), which are likely new to them. The graphical representation of data in number lines highlights the immense differences in scale and proportion among celestial objects, particularly emphasizing their vast sizes and the significant variations in distances between them. Finally, students apply their understanding of scale and proportion to explain why the Sun appears so distinct from other stars. By analyzing differences in size and distance over immense scales, students individually conclude and argue that while stars vary greatly in their distances from Earth, the Sun's proximity makes it appear vastly larger and brighter than the more distant stars, despite its similar classification as a star and smaller relative size. (SPQ-E1, SPQ-E2)

Systems and Systems Models (SYS)

Grades K-2 Elements of Systems and System Models

CCC Element	Description of Elements in Grades K-2
SYS-P1	Objects and organisms can be described in terms of their parts.
SYS-P2	Systems in the natural and designed world have parts that work together.

Grades K-2 Progression for Systems and System Models

Unit	Support for Growth in Systems and System Models in Grades K-2
K.1 Energy: Sunlight	**Not Claimed**
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Not Claimed**
K.4 Plants, Animals, & Environments	**Intentionally Developed:** While the term "system" is not used with students in this grade band, students are supported in using systems thinking and developing system models as they describe parts of birds' environment in a local area. They similarly identify parts of other birds'

Unit	Support for Growth in Systems and System Models in Grades K-2
	environments when they use bird cards and videos to describe what is around the birds and what they interact with. Students use systems thinking to describe the relationships between various parts of the environment (e.g., water, animals, and plants used for food or shelter) and birds meeting their needs (parts of a system working together), and add these relationships to the class model. Then students engage in similar activities using systems thinking to investigate and explain how other plants and animals meet their needs. They identify parts of different plants' and animals' environments, and explain how the various parts work together for plants and animals (including people) to meet their needs through using and changing parts of their environments. Since this is their first time using this concept, students' work is supported throughout the unit by class discussions and teacher prompting. (SYS-P2)
1.1 Waves: Light	**Not Claimed**
1.2 Waves: Sound	**Not Claimed**
1.3 Space: Sky Patterns	**Not Claimed**
1.4 Animal & Plant Traits	**Not Claimed**
2.1 Earth: Land Changing Shape	**Not Claimed**
2.2 Structure & Properties of Matter	**Not Claimed**
2.3 Habitats & Biodiversity	**Opportunity to Practice:** Students describe plants and animals in terms of their parts when they make observations of plants and animals in the schoolyard and their researched national park. They use observations of plants and animals' parts to figure out how different kinds of plants and different kinds of animals are similar to and different from one another. (SYS-P1)
2.4 Plants	**Opportunity to Practice:** Students consider how certain seeds and animals are parts that work together in the natural world as a "seed-and-animal" system that makes it possible for seeds to be moved to new places. Specifically, students consider seeds that stick to animals' surfaces and seeds that can be picked up, moved, and buried by animals' mouths/paws/beaks. Similarly, they consider how pollen and pollinators work together as a "pollen-and-animal" system that makes it possible for pollen to be moved from one flower to another. (SYS-P2) Note that the term "system" is not used with students in this unit in order to help them focus on making sense of structure-function relationships instead.

Grades 3-5 Elements of Systems and System Models

CCC Element	Description of Elements in Grades 3-5
SYS-E1	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
SYS-E2	A system can be described in terms of its components and their interactions.

Grades 3-5 Progression for Systems and System Models

Unit	Support for Growth in Systems and System Models in 3-5
3.1 Forces & Interactions	**Intentionally Developed:** This unit intentionally develops the concept of systems as students consider the idea of a sculpture as containing multiple parts and students begin to model different sculptures and how they work (named as systems later in the unit). Students develop a deeper understanding by working as a class to represent the different parts and interactions in the system in a Class Consensus Model (SYS-E2). As the unit goes on, students make sense of the idea that a system is a group of related parts that can carry out functions its individual parts cannot as they figure out how artists get all the parts of a balance sculpture to work together so it can move (or not) (SYS-E1). Throughout the unit, students' work with this concept is supported by teacher prompts, class discussions, and consensus modeling.
3.2 Weather & Hazards	**Opportunity to Practice:** Students work as a class to identify the essential components and interactions included in their Class Consensus Model to explain how a windbreak works to protect plants from strong winds (SYS-E2). Students also work as a class to consider how their windbreak design solutions might influence more than just the fruit trees they protect, which are only one part of the larger ecosystem (SYS-E1).
3.3 Trait Variations	**Not Claimed**
3.4 Ecosystem Change & Survival	**Intentionally Developed:** Students use system models to understand the components of the three water habitats they are investigating and how a change to those components affects interactions in the system. Students explicitly discuss the term "interaction," and the Class Consensus Model, which is co-constructed and updated throughout the unit, supports students in describing the components of the habitats (rivers and springs, coastal ocean, and deep ocean) and the interactions therein. At the end of the unit, students work independently to propose changes to a system and make claims about how the new system will work to protect manatees. (SYS-E2)
4.1 Energy Transfer: Collisions	**Opportunity to Practice:** Students frequently use this practice when they describe the components and interactions represented in the Class Consensus Model and when they describe and use their Kick Investigation System to plan and carry out investigations related to energy and energy transfer in collisions (SYS-E2).

Unit	Support for Growth in Systems and System Models in 3-5
4.2 Energy Transfer: Electricity	**Not Claimed**
4.3 Earth Processes	**Not Claimed**
4.4 Structure & Function	**Intentionally Developed:** Initially in this unit, students are focused on figuring out how animals' structures work together in their body systems to help them survive and grow. Later, students investigate how information from sense receptors and memories can guide animals' actions; they support this work with flow-chart-type systems models. Finally, students transition to exploring plants and the structures that interact to support their growth and reproduction, functions that could not be carried out by individual parts. Throughout this unit, students are supported in developing this concept as they construct numerous scaffolded models as a class, with partners, and individually. (SYS-E1)
5.1 Ecosystems & Matter Cycling	**Intentionally Developed:** Students analyze the nurse log phenomenon to consider the components, interactions, and processes of the system, and how the organisms and the processes they undertake to get, use, and release matter and energy are vital to one another's survival. Students zoom into different parts of the whole nurse log system to investigate the plant system, the animal system, and the decomposer system. By the conclusion of the unit, students have iteratively developed a systems model and use it independently to describe how living things interact with one another in an ecosystem and have impacts on that ecosystem (SYS-E2).
5.2 Matter Properties	**Not Claimed**
5.3 Earth Systems	**Intentionally Developed:** Students begin this unit by exploring the ways that the interactions of the components of the Elwha River system could change based on the addition of dams on the river. Students work together to define the system and the components that it includes. They work with small groups, partners, and independently to explain the effects of changes to the river system and changes to systems in other communities, including their own. Students also explore water systems in specific locations. They consider the components of these localized water systems and the ways that altering parts of the system can have an impact on the interactions of the components. (SYS-E2)
5.4 Sun, Moon, & Star Patterns	**Not Claimed**

Energy and Matter (EM)

Grades K-2 Elements of Energy and Matter

CCC Element	Description of Element in Grades K-2
EM-P1	Objects may break into smaller pieces and be put together into larger pieces, or change shapes.

Grades K-2 Progression for Energy and Matter

Unit	Support for Growth in Energy and Matter in K-2
K.1 Energy: Sunlight	**Not Claimed**
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Not Claimed**
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Not Claimed**
1.2 Waves: Sound	**Not Claimed**
1.3 Space: Sky Patterns	**Not Claimed**
1.4 Animal & Plant Traits	**Not Claimed**
2.1 Earth: Land Changing Shape	**Not Claimed**
2.2 Structure & Properties of Matter	**Intentionally Developed:** After sharing experiences with toys, students participate in an interactive read-aloud that (re)introduces them to toys that come in sets. Students work in small groups and as a class to figure out that many objects can be made of smaller pieces and those objects can be taken apart and put back together in different ways. Later in the unit, students

Unit	Support for Growth in Energy and Matter in K-2
	apply this crosscutting concept to their toy design as they identify the objects and materials that their toy is made of. Students meet in small groups to consider the different ways they used the same material and what they had to do (break into smaller pieces, change shape) to use that object to make their toy (larger object). (EM-P1)
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Not Claimed**

Grades 3-5 Elements of Energy and Matter

CCC Element	Description of Elements in Grades 3-5
EM-E1	Matter is made of particles.
EM-E2	Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.
EM-E3	Energy can be transferred in various ways and between objects.

Grades 3-5 Progression for Energy and Matter

Unit	Support for Growth in Energy and Matter in Grades 3-5
3.1 Forces & Interactions	**Not Claimed**
3.2 Weather & Hazards	**Not Claimed**
3.3 Trait Variations	**Not Claimed**
3.4 Ecosystem Change & Survival	**Not Claimed**
4.1 Energy Transfer: Collisions	**Intentionally Developed:** After a few investigations about how kicks make balls move, students work as a class to name the "push that keeps going" or "oomph" that the kick gives the ball as "energy." This is the first time in their formal science work that students begin to make sense of energy. Continued work in the unit is supported by the questions, "Where does the energy come from?" and "Where does the energy go?" Students figure out from further

Unit	Support for Growth in Energy and Matter in Grades 3-5
	small group investigations of colliding objects that energy can be transferred from one object to another, and that changes in motion are evidence of energy transfer. Students conduct further investigations to identify that sound and heat are other ways energy can be transferred between objects, and that sound and heat are evidence of energy transfer. Students individually use this concept to explain what they figured out on summative assessment tasks. (EM-E3)
4.2 Energy Transfer: Electricity	**Intentionally Developed:** Students continue their work to figure out how energy can be transferred between objects in various ways as they investigate winding and plug-in clocks. They work as a whole class and in small groups to identify the changes in motion, sound, and light in clocks and other devices as caused by energy, and from there continue to gather evidence for identifying when energy transfer has occurred. They investigate electrical currents and come to realize that currents are a way that energy is transferred from place to place via wires. Later, students work in small groups to investigate usable energy sources, and learn that energy transfer is required for electricity to be generated from a source and to reach the devices they plug into outlets. Finally, students work with small groups and the class to develop an understanding that energy transfer is required for information to be sent and received, and that digitizing information facilitates sending it across long distances using light or sound. At multiple points throughout the unit, students have individual opportunities to show their use of this concept on formative and summative assessments. (EM-E3)
4.3 Earth Processes	**Not Claimed**
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Intentionally Developed:** As students make sense of how a nurse log supports many organisms, they figure out for the first time (formally in school) that matter is made of particles too small to see. They work in small groups and as a class to investigate how plants get the matter they need to grow and discover that it comes from both water and air (EM-E1). They also figure out that energy can be transferred in various ways when they make sense of why plants need light to grow (in addition to air and water) and when they investigate how consumers and decomposers get energy from food (EM-E3). Throughout the unit, students discuss and make sense of matter being transported into, out of, and within systems (focusing on the nurse log system). They work in small groups to investigate plants growing, basketballs filled with more and less air, termite colonies, mushrooms, and the entire nurse log food web to make sense of how matter can be tracked in terms of the weight of the substances before and after a process occurs because the total weight of the substances in a system does not change (EM-E2). Students use this crosscutting concept to independently develop models and construct arguments to explain what they have figured out at multiple points in the unit.
5.2 Matter Properties	**Intentionally Developed:** Students continue to apply what they figured out about matter in Unit 5.1 to make sense of ideas in a different context in this unit. They work as a class to identify that the materials in the water sample are matter, and they work in small groups to measure how much matter their filter takes out of the water by weighing the sample before

Unit	Support for Growth in Energy and Matter in Grades 3-5
	and after filtering (EM-E2). Students also have another experience figuring out that matter is made of particles too small to see when they read in pairs about related phenomena and then develop models that show that water can look clear but still have particles of a different kind of matter in it (EM-E1). Students also work in pairs and as a class to identify heat from the Sun as evidence of energy transfer when explaining how the solar still works (EM-E3).
5.3 Earth Systems	**Not Claimed**
5.4 Sun, Moon, & Star Patterns	**Not Claimed**

Structure and Function (SF)

Grades K-2 Elements of Structure and Function

CCC Element	Description of Element in Grades K-2
SF-P1	The shape and stability of structures of natural and designed objects are related to their function(s).

Grades K-2 Progression for Structure and Function

Unit	Support for Growth in Structure and Function in K-2
K.1 Energy: Sunlight	**Opportunity to Practice:** Students use this concept to support the building and evaluation of their engineering designs as they consider how the shape and stability of the structures they design are related to the function of making the blacktop feel less hot. The terms “structure” and “function” are not used with students at this grade level (SF-P1).
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Opportunity to Practice:** Students design, test, and revise a straw path that changes the direction of a moving ball. They consider how the shape of the structure affects its function to guide the ball from the starting point, around an obstacle, and to the ending point. (SF-P1)
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Not Claimed**

Unit	Support for Growth in Structure and Function in K-2
1.2 Waves: Sound	**Intentionally Developed:** Students work as a class to use structure-and-function reasoning in the context of bells and ears, considering how the shape of these objects may relate to their function in making and receiving sound. The terms "structure" and "function" are not used with students at this grade level. In the context of engineering, students work in pairs to plan how the shape (parts) of their sound signal device connect to its function of making sound. Also, while building their designs in pairs, students consider how the materials and parts (structure) help the device function in ways beyond making sound, for example, being stable and/or staying intact. Students test their devices to gather evidence for how well they work to make and send a good news message across the classroom (function), relating this evidence to the parts and materials (structure) of their design. Students individually use this concept at the end of the unit when they communicate information about how their design's structure helps it function. (SF-P1)
1.3 Space: Sky Patterns	**Not Claimed**
1.4 Animal & Plant Traits	**Intentionally Developed:** Students use structure-function thinking when they make observations of external parts and consider how the shapes might help plants and animals live and grow. The terms "structure" and "function" are not used with students at this grade level. Students then investigate this relationship more explicitly using time-lapse videos, hands-on investigations, and physical models to connect the shapes of plant and animal parts to their functions, such as how roots absorb water or how different foot shapes support different kinds of movement. Students engage with these ideas during whole class discussions and small-group or partner work. The class continues developing this idea by examining how parents and offspring use their parts to engage in behaviors that help offspring survive. Finally, students apply this concept to the designed world as they use what they figured out to individually design solutions that mimic external parts of plants and animals to solve human problems and share how their structures help them function. (SF-P1)
2.1 Earth: Land Changing Shape	**Intentionally Developed:** Students work in small groups to use structure and function thinking as they build, test, and evaluate their land change bins for effectiveness. Later, students redesign their land change bin models and test them to determine if the shape and stability of their models mimic the function of the real-life problem. After establishing that the bin functions as intended, students consider the shape and stability of existing solutions and develop drawings of their proposed design solutions to incorporate some of those ideas into their designs. Students work in pairs to test and evaluate how successful their solutions were and share with the group. Finally, students individually use ideas of structure and function to complete a summative assessment explaining which design solution was the most effective and why. (SF-P1)
2.2 Structure & Properties of Matter	**Intentionally Developed:** As students develop a new toy from a set of materials, they consider how the shape of the parts of the toy will allow the toy to function in the way that is intended. When designing their toys, students work in pairs to consider how to build the toy (structure) so that it meets the needs of the kindergartners (function). From there, students identify the materials and the shapes that those materials need to have in order for the toy to function in the way that it is intended. Classmates provide feedback about the function of the toy and make recommendations for how their peers might change the shape of materials to improve the toy's

Unit	Support for Growth in Structure and Function in K-2
	function. Finally, students work in pairs to communicate to a kindergartner how the toy functions as a result of the different shapes and structures of objects working together. (SF-P1)
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Intentionally Developed:** Students expand on structure-function relationships in natural examples that they figured out in Units 1.2 and 1.4, and they expand on that work here when they use structure-and-function reasoning to make sense of how seeds and pollen can be moved to new places so that plants can grow there. Students work with partners to make careful observations of seeds and surfaces (using hand lenses) to notice differences in structures, focusing on how they look, including their shape, as well as their textures (how they feel), and make observations using infographics about the structures of animals' body parts (mouths, paws, beaks). Through investigation and class discussion, students are able to relate the shape of structures (seeds, surfaces, body parts) to their functions in moving seeds to new places. Specifically, students identify seed structures that make it possible to be moved by the wind; seed and surface structures that make it possible (or not possible) to be moved by sticking together; and structures of seeds and animal body parts that make it possible for a seed to be moved to a new place when an animal picks up the seed, holds it while moving, and buries it somewhere new. Students also figure out that structures of pollen (e.g., tiny pieces) and pollinators (e.g., fuzzy surfaces of bees) make it possible for pollen to be moved to new places. Students individually use this concept when they develop a model to explain how a seed could have gotten on top of a tower to start growing there. (SF-P1)

Grades 3-5 Elements of Structure and Function

CCC Element	Description of Elements in Grades 3-5
SF-E1	Different materials have different substructures, which can sometimes be observed.
SF-E2	Substructures have shapes and parts that serve functions.

Grades 3-5 Progression for Structure and Function

Unit	Support for Growth in Structure and Function in Grades 3-5
3.1 Forces & Interactions	**Opportunity to Practice:** Students test different shapes and the types of motions the shapes produce on a moving sculpture (SF-E2). They also consider how only certain types of metals are attracted to magnets while others are not, which supports students in beginning to observe the substructures of different materials, although that term is not used in this unit (SF-E1).
3.2 Weather & Hazards	**Opportunity to Practice:** Students generate and test different windbreak designs and consider how the different parts of the windbreak prototypes work (or do not work) to reduce the impact to fruit plants (SF-E2).
3.3 Trait Variations	**Not Claimed**
3.4 Ecosystem Change & Survival	**Not Claimed**
4.1 Energy Transfer: Collisions	**Not Claimed**
4.2 Energy Transfer: Electricity	**Not Claimed**
4.3 Earth Processes	**Not Claimed**
4.4 Structure & Function	**Intentionally Developed:** Students begin the unit by exploring the body parts of flying squirrels and notice and wonder about some of the structures and substructures of the squirrels' bodies. They are supported in using the lens of structure/function by guiding questions as they create initial models individually and as a class. Then students work with partners to specifically investigate the shape and function of the flying squirrel's leg substructures: the patagium (skin flap) and bones, discussing their findings as a class. Finally, students use the concept of substructures to help them understand how plant parts function

Unit	Support for Growth in Structure and Function in Grades 3-5
	when they investigate a celery stalk's xylem and figure out how its shape serves the function of moving water through the plant. (SF-E2)
5.1 Ecosystems & Matter Cycling	**Not Claimed**
5.2 Matter Properties	**Not Claimed**
5.3 Earth Systems	**Not Claimed**
5.4 Sun, Moon, & Star Patterns	**Not Claimed**

Stability and Change (SC)

Grades K-2 Elements of Stability and Change

CCC Element	Description of Elements in Grades K-2
SC-P1	Some things stay the same while other things change.
SC-P2	Things may change slowly or rapidly.

Grades K-2 Progression for Stability and Change

Unit	Support for Growth in Stability and Change in Grades K-2
K.1 Energy: Sunlight	**Not Claimed**
K.2 Weather	**Not Claimed**
K.3 Forces in Motion	**Not Claimed**

Unit	Support for Growth in Stability and Change in Grades K-2
K.4 Plants, Animals, & Environments	**Not Claimed**
1.1 Waves: Light	**Not Claimed**
1.2 Waves: Sound	**Not Claimed**
1.3 Space: Sky Patterns	**Not Claimed**
1.4 Animal & Plant Traits	**Not Claimed**
2.1 Earth: Land Changing Shape	**Intentionally Developed:** Students make observations from a puzzling newscast about land changing shape and propose causes about how the land is changing. Students then identify patterns from their small-group investigations about wind and water moving land, and discover that some types of land move very little, if at all. Later, students notice that large rocks do not seem to be moved by them blowing on them or dumping water on them, and they begin to wonder more intently about the timescales over which these changes occur, if they occur at all. Students also conduct a whole-class investigation with a salt rock to determine that not all changes happen within seconds (relatively rapidly) and that rocks might change shape over a longer period of time. Finally, students use observations as evidence in small groups and as a class to establish that changes in the shape of rocky land happen over much larger timescales. Students also have an individual opportunity to apply this crosscutting concept in a summative assessment task. (SC-P2)
2.2 Structure & Properties of Matter	**Not Claimed**
2.3 Habitats & Biodiversity	**Not Claimed**
2.4 Plants	**Not Claimed**

Grades 3-5 Elements of Stability and Change

CCC Element	Description of Elements in Grades 3-5
SC-E1	Change is measured in terms of differences over time and may occur at different rates.
SC-E2	Some systems appear stable, but over long periods of time will eventually change.

Grades 3-5 Progression for Stability and Change

Unit	Support for Growth in Stability and Change in Grades 3-5
3.1 Forces & Interactions	**Not Claimed**
3.2 Weather & Hazards	**Not Claimed**
3.3 Trait Variations	**Opportunity to Practice:** Students use this concept to consider changes that happen over time and at different rates related to puppies' growth and development and the life cycles of various animals (SC-E1).
3.4 Ecosystem Change & Survival	**Opportunity for Practice:** Students use this concept when they research the problems affecting manatees and the kinds of changes happening in their habitats (which may have seemed stable); some changes are quick (e.g., closing of a power plant) and some take place over longer periods of time (e.g., loss of seagrass) (SC-E1, SC-E2).
4.1 Energy Transfer: Collisions	**Not Claimed**
4.2 Energy Transfer: Electricity	**Not Claimed**
4.3 Earth Processes	**Opportunity to Practice:** Students use this concept when they consider the timescale in which land changes they observed occurred. They create a chart to track examples of changes to land and the timescale of how long the change took to occur. (SC-E1)
4.4 Structure & Function	**Not Claimed**
5.1 Ecosystems & Matter Cycling	**Not Claimed**
5.2 Matter Properties	**Not Claimed**
5.3 Earth Systems	**Opportunity to Practice:** Students use this concept when they analyze how precipitation and water flow change across a year. They also consider how the freshwater system in the location that they are researching has been working for a long period of time, thereby appearing stable. They then see how the system is being changed rapidly by human overuse of freshwater. (SC-E1, SC-E2)

Unit	Support for Growth in Stability and Change in Grades 3-5
5.4 Sun, Moon, & Star Patterns	**Intentionally Developed:** Students work as a class and with partners to analyze changes to understand the degree of variation in the apparent motion of celestial objects. Awareness of changes measured in differences over time and occurring at different rates enhances their ability to construct arguments as a class and individually about the daily movements of the Moon and how some patterns of the Sun's apparent motion occur. (SC-E1)

Appendix E: Guidance for Flexible Sequencing

How does OpenSciEd Elementary support coherent learning for students while also providing opportunities for flexible sequencing?

One design goal for OpenSciEd Elementary was to support flexible sequencing of units within a year, to the extent possible, so that schools with multiple classrooms within a grade could consider sharing classroom resources by teaching units in different orders. However, we prioritized creating a meaningful learning sequence for students. The Framework for K-12 Science Education and NGSS emphasizes the need for coherence and the intentional building of all three dimensions as necessary for equitable science education. OpenSciEd Elementary materials value and build on the knowledge and experiences of all students as they progress from grade to grade. This development of ideas is critical for making science more meaningful for students and helping them develop deeper and more generative science ideas and practices. Prioritizing coherence also leads to some constraints on flexible ordering of all units.

Grade-Level Organization of Units

As mentioned in our description of bundling PEs into units, the first sequencing commitment built into the program design comes from the design of learning pathways into the K-2 and 3-5 grade bands in A Framework for K-12 Science Education, and the refinement of these pathways into grade level targets in the NGSS.

Rearranging units so they occur in different grade levels (e.g., moving Unit 2.3 into kindergarten or first grade) could disrupt the scaffolded learning of the three dimensions across grade levels. In making a decision to reorder the sequence, it would be important to check for cross-grade connections in the program (Figure 1) that would be violated. See the appendices for the DCI, CCC, and SEP connections that are built into this program. We recommend careful consideration of the resources that would be required for revision, a careful examination of priorities and policies that might be motivating such a revision, and a cost/benefit analysis that focuses on the benefits for student learning.

Where is flexibility possible in sequencing units within a year?

Figure 2 shows where sequencing choices exist for districts or schools that want to rearrange units within grade levels, such as for sharing materials across classrooms.

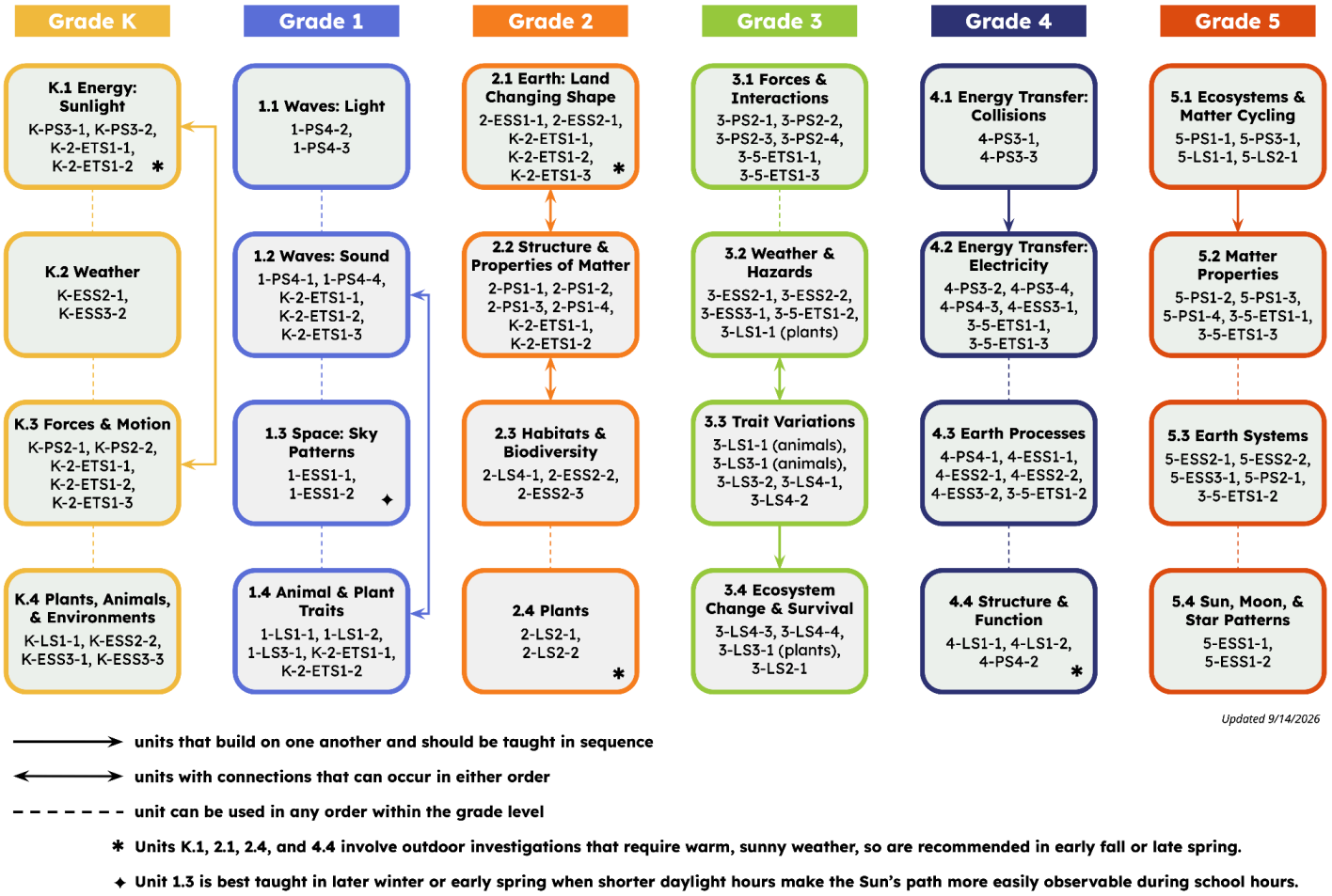


Figure 2: Map indicating options and limitations for flexible sequencing within grades.

Within each grade level, we designed the four units to enable as much flexibility in sequencing as possible. Units whose order can be easily rearranged are those units connected by *dashed lines* in Figure 2. This means that these units within a grade level are essentially modular, and can be taught out of the recommended sequence, in any order, without disrupting students' opportunities to coherently develop their understandings of SEPs, CCCs, and DCIs. For example, the four units in first grade could be taught in any order within their respective years in terms of building the science ideas and practices. Thus, these dashed lines between units indicate units where altering the sequence can be done without modifying the units themselves, because the work of one unit is relatively independent of the work of the other unit.

A potential constraint on the flexibility of units connected by dashed lines arises for several units that include outdoor investigations with specific weather or timing needs (e.g., K.1, 1.3), and so may be affected by seasonal constraints, depending on the climate in your area. The recommended sequence is designed to fit best with typical weather during the school year in most of the U.S. The units with outdoor investigations best done in warm, sunny weather are recommended to occur at the very beginning and very end of the school year. Before deciding to rearrange the order of units connected by dashed lines, consult the Teacher Handbook for details about the outdoor investigations used in those units.

Flexibility in the recommended sequence is not restricted to the relatively independent units connected by dashed lines. Another type of flexibility built into the program is indicated by *double-headed arrows*, such as the connections of 2.1 ↔ 2.2 and 2.2 ↔ 2.3. Like dashed lines, these double-headed arrows indicate that the pair of units could be taught in either order. However, these units do not contain *independent* content. In units with double-headed arrows, it is important for teachers to help students connect the ideas from one unit to another. For example, Units 3.2 and 3.3 both support figuring out ideas about life cycles within their respective storylines, with plant life cycles in 3.2 and animal life cycles in 3.3. Each unit provides guidance for teachers to support students in connecting what they figure out with plants to what they figure out with animals. The guidance provided enables teachers to make these connections regardless of the order in which these units are taught. Thus, flexibility in sequencing within a grade is not only applicable to units with independent and discrete content (units linked by dashed lines in Figure 2).

There are also two double-headed arrow connections between non-sequential units, K.1↔ K.3 and 2.1 ↔ 2.3. Like units that follow one another in the recommended order, these units provide guidance for teachers to help students make important connections between the ideas in one unit and the other.

To explore how these links work together, consider the grade-specific descriptions that follow. It is often not necessary for all classrooms in a school to follow the same path, if it is helpful to share unit-specific classroom instructional resources such as toy cars, binoculars, and read-aloud texts.

The **kindergarten** units could be taught in any order, as long as Unit K.1 is taught when there is warm sunny weather suitable for its outside investigations. As specified by the double-headed arrow in Figure 2, teachers should support students making connections between the engineering ideas in Units K.1 and K.3, regardless of which unit is taught first.

The **first grade** units could be taught in any order, as long as Unit 1.3 is taught when students will be able to observe the Sun's path through the sky during school hours (usually easiest in late winter or early spring). As specified by the double-headed arrow in Figure 2,

teachers should support students making connections between the engineering ideas in Units 1.2 and 1.4, regardless of which unit is taught first.

The **second grade** units have two units with seasonal considerations: Units 2.1 and 2.4 both involve multiple outdoor investigations that need warmer weather. Other than that, the units can be taught in any order. Double-headed arrows in Figure 2 indicate that teachers are supported in making connections between Units 2.1 and 2.2, and Units 2.2 and 2.3, regardless of the order in which they are taught.

In **third grade**, it is important that students experience Unit 3.3 before Unit 3.4 so they can build ideas about inheritance from animals (first) to plants (second). However, other units can occur in any order. For example, the year could begin with Unit 3.3, then Unit 3.2, Unit 3.4, and end with Unit 3.1. The double-headed arrow between units 3.2 and 3.3 in Figure 2 indicates that teachers are guided to make connections between plant and animal life cycles regardless of which they experience first.

In **fourth grade**, it is important that students experience Unit 4.1 before Unit 4.2 so they can build ideas about energy transfer from more easily observable to more abstract. Also, Unit 4.4 involves outdoor investigations that require warmer weather. The dashed lines between the other fourth grade units in Figure 2 indicates that they can be taught in any order. So a potential path could be to begin the year with Unit 4.4, then Unit 4.3, Unit 4.1, and end with Unit 4.2.

In **fifth grade**, it is important that students experience Unit 5.1 before Unit 5.2 so they can develop foundational ideas about the particle nature of matter in Unit 5.1 before using those ideas in a different context in Unit 5.2. The dashed lines between the other fifth grade units in Figure 2 indicate that the units can be taught in any order. For example, the year could begin with Unit 5.3, then Unit 5.1, Unit 5.2, and end with Unit 5.4.

What should teachers do if students have not used OpenSciEd in previous years?

If connections are important in the design of OpenSciEd Elementary, what can teachers do if some (or all) students did not use OpenSciEd materials in their earlier grades? Let's consider two different scenarios. In the first case, if students have experienced a full course of a high-quality NGSS-designed science curriculum other than OpenSciEd, they should have developed the ideas and practices for the earlier-grade performance expectations that are referenced in the cross-grade connections in OpenSciEd Elementary units. So while the phenomenon context is likely different from what was used in the OpenSciEd unit, you can still talk with the students about what they figured out about habitats, the needs of plants, or whatever important ideas are referenced in the teacher guidance.

If some or all of your class did not experience a high-quality NGSS-designed science curriculum in earlier grades, you will have opportunities to evaluate students' incoming ideas and questions, especially during the first lesson of each unit. Pre-assessment and formative assessment guidance provided in the teacher guides will help you identify gaps and plan for working with students to build background ideas and practices as needed. As a helpful reference, each unit's Front Matter section also describes ideas students are expected to bring into and build upon in the unit.