Decoding NGSS/NYSSLS

The adoption of the Next Generation Science Standards, and similar science standards based on the NRC Framework for K-12 Science Education (e.g., NYSSLS in New York), resulted in many changes to K-5 science curriculum requirements and assessments.

"What does it all mean?" "How am I supposed to fit everything in?" "Realistically, how am I supposed to incorporate these new learning objectives into my daily lessons?" These are just a few of the reactions we hear from K-5 teachers across the country.

So we launched this tip series, Decoding the NGSS, to help interpret the spirit of NGSS and provide simple ways to incorporate 3-dimensional learning and the nature of science into your busy K-5 classroom.

Tip Index

TIP #1 - Connections: Engineering, Technology, and Applications of Science: Influence of Engineering, Technology and Science on Society and the Natural World

They say necessity is the mother of invention, and in many cases necessity is driven by a community need. Louis Pasteur invented the rabies vaccine to help people around his country. Huda Elasaad is developing mobile water purification plants to help bring clean water to small, hard-to-serve communities around the world today.

Invention and entrepreneurship are a great way to connect what your students are learning to their communities. Incorporating both into your science instruction lets students learn first-hand how engineering, technology and science influence, and improve, our society.

The CreositySpace Approach

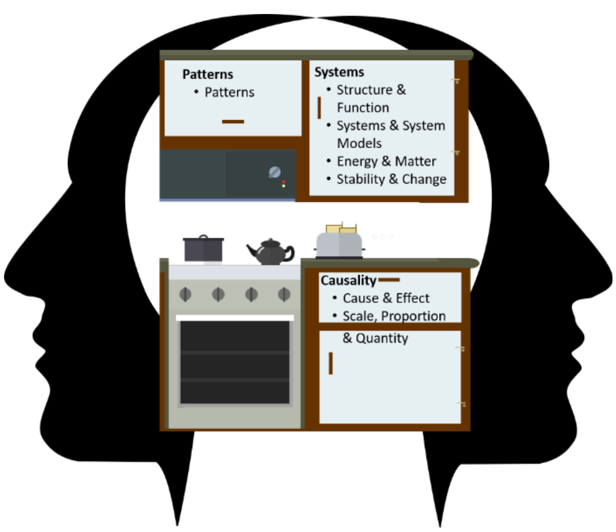
Every CreositySpace unit features a number of STEM entrepreneurs and their technology innovations and businesses—highlighting the community need that drives their motivation. These entrepreneurs' stories provide the spark and road map for students to look for needs in their own lives and communities, and to use their science and engineering knowledge to develop potential solutions.

TIP #2 - Crosscutting Concepts: Crosscutting Concepts Front and Center

The “Kitchen Organizers” for Understanding and Using Scientific Knowledge

The crosscutting concepts (CCCs) —previously labeled as "themes" or "unifying principles"— are the mental bins into which different pieces of information can be organized. As in your kitchen, you have a cupboard for plates (e.g., patterns), one for glasses (e.g., structure function), and a cutlery drawer (e.g., cause and effect).

In each of these bins you have a lot of different items which represent the performance expectations (PEs), science and engineering practices (SEPs), and disciplinary core ideas (DCIs). These are like the knives, forks, and spoons in the cutlery drawer. You know that if you need something to eat your food with you look in the cutlery drawer. Similarly, if you are trying to understand the result of an event (e.g., what do plants need to grow?) you look in your “cause and effect drawer" (e.g., plants need water and sun to grow).



The CCCs help students understand where in their mind they should "put" the information they are learning; what other knowledge might be "related to" what they are learning, and how they might be able to use that knowledge to understand or solve new problems. CCC connections enable a deeper understanding of individual pieces of information by formally connecting them to similar types of information from other disciplines (e.g., information that can be used in a similar problem-solving way).

The CreositySpace Approach

By connecting every core idea, science and engineering practice and performance expectation to a real-world application, CreositySpace helps students see the knowledge and information they are gaining "in action." This "action" embodies the concept of "how the information is being used" and forms a natural and intuitive connection to the related CCC.

For example, in *Battery Builders* (grade 5), the investigations “Materials Mix-Up” and “Build a Better Battery” require students to identify patterns in materials properties and connect them to the performance of a battery they are building. In Green Architects (grade 2), students explore various components of sustainable design (living walls, environmentally friendly building practices, etc.) by evaluating both the structure and the function of various alternatives. The columns below illustrate some additional examples of how the crosscutting concepts are naturally front and center in every CreositySpace unit.

Crosscutting Concepts

Green Architects (grade 2)

Patterns
Mapping activities (What’s Available?) and weather and climate discussions (What’s It Like Outside?) have students finding patterns in the natural world. The discussion around structural elements of green building design connect patterns found in nature to green architecture.

Cause and effect
In the hands-on investigation (The Wall is Alive) students determine cause and effect relationships between plants and their environment. The summative challenge and videos emphasize environmental cause and effect and the concept of balancing availability and demand of resources.

Systems and system models; Energy and matter: Flows, cycles, and conservation
In both The Wall Is Alive investigation and the Building a Green Building summative challenge students work with model systems to illustrate larger scale ecosystem interactions and energy and natural resource management respectively.

Structure and function
The living wall and other green building elements connect and demonstrate structure and function in both the natural world and the human-made world.

Stability and change
By studying how a building must protect those inside from the outside elements (What’s It Like Outside?, Which Is Better? You Decide!), students evaluate how the weather and climate changes on both a short and long timescale.

Water Watchers (grade 3)

Patterns
Investigations on water-based energy generation (Water Engineers), global climates (Design Your Plant), and animal migration behavior (Nature’s Water Watchers) have students identifying patterns and using them to predict or explain future events.

Cause and effect
Introductory challenge (Separation Strategies), filtering engineering design challenge (Becoming a Water Washer) and various modeling activities have students identifying and applying cause and effect relationships.

Systems and system models
Students use models and model systems (Becoming a Water Washer, Nature’s Water Watchers) to explore and explain different scientific concepts.

Structure and function
Entrepreneurs and design challenge highlight how the structure and properties of materials can be used to perform specific functions.

Battery Builders (grade 5)

Patterns
Materials Mix-Up and Build a Better Battery have students identifying patterns and connecting them to performance.

Cause and effect
The Build a Basic Battery and Build a Better Battery hands-on investigations have students studying a variety of cause and effect relationships.

Systems and System Models, Energy and Matter
Battery building and electrolyte investigations and models represent systems, system models, and a connection between energy and matter. Entrepreneur discussions highlight the connections and interactions between scientific discoveries and the larger community.

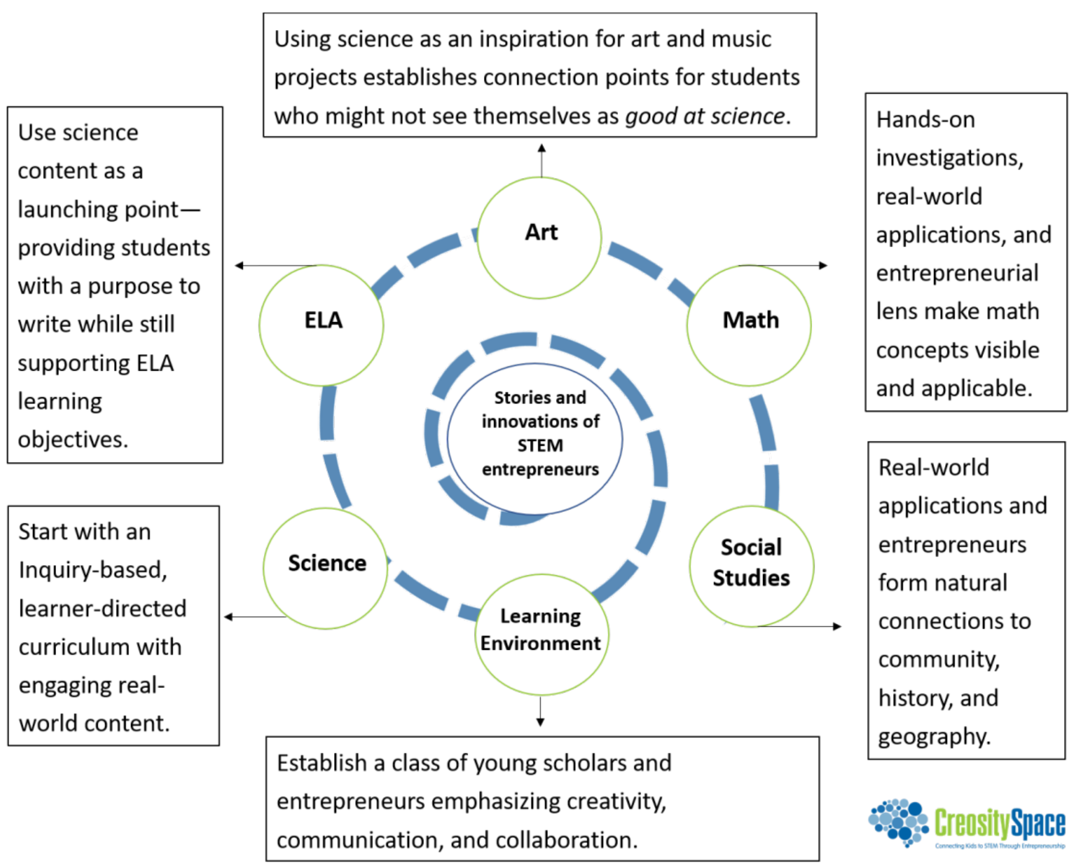
Structure and function
Entrepreneurs highlight how the structure and properties of materials can be used to perform specific functions. Design challenges reinforce structure-function relationships.

Scale, Proportion, and Quantity
Discussions of energy and electricity, salt dissolution, and nano-scale properties in general (Build a Basic Battery, Build a Better Battery) highlight scale and proportion.

TIP #3 - Subject Integration: Time: The Illusive "Golden Snitch" in Elementary Classrooms

The Next Generation Science Standards (NGSS) promote a philosophy of inquiry-based student-directed learning. While this approach is shown to be more effective at reaching all students (1,2,3) there is little debate that this teaching method takes more "classroom hours" than teacher-based direct instruction. So, in an elementary day, with teaching time already constrained by students leaving for RTI, out-of-classroom specials, and a national focus on ELA and math, how do you find more time to teach science?

One commonly employed strategy is integration. Science concepts form a natural motivation for students to practice and develop many skills that are central to ELA, math, social studies, and art standards. Why not use your science content as topics in those lesson blocks?



Example 1: Integration with ELA

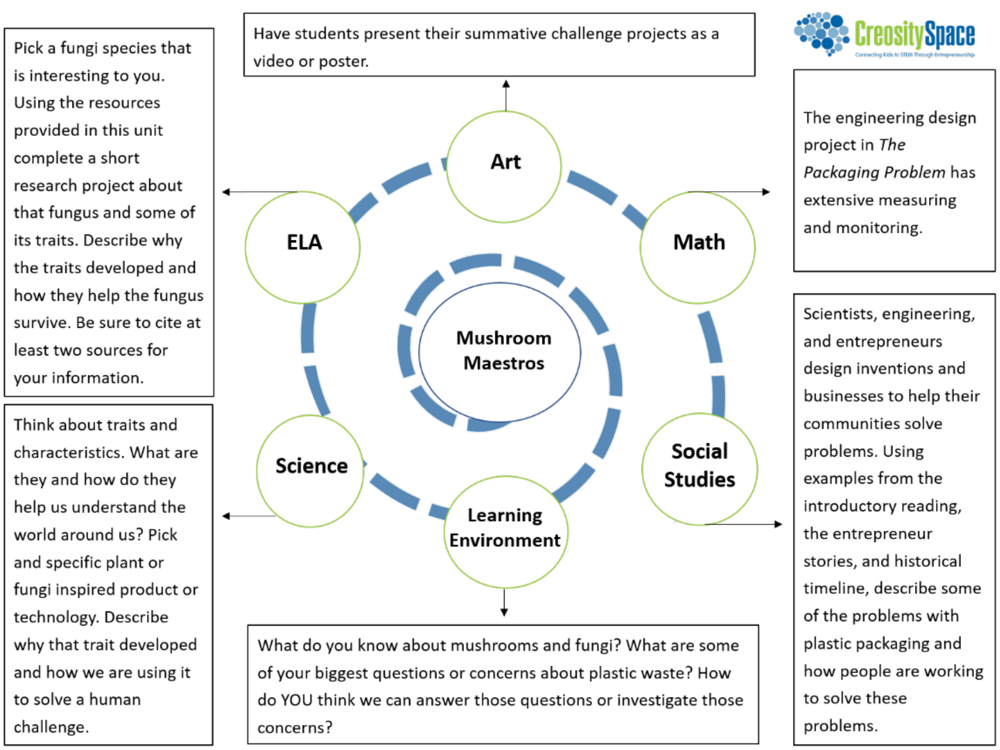
The completion of mini research projects, based on scientific topics, students are both learning key scientific content (e.g., 3-LS4-2; 5-ESS1-1) and practicing a variety of ELA writing (e.g., W3.2,7,8; W5.2,7) and reading (e.g., RI3.5; RI5.2,3,5) skills.

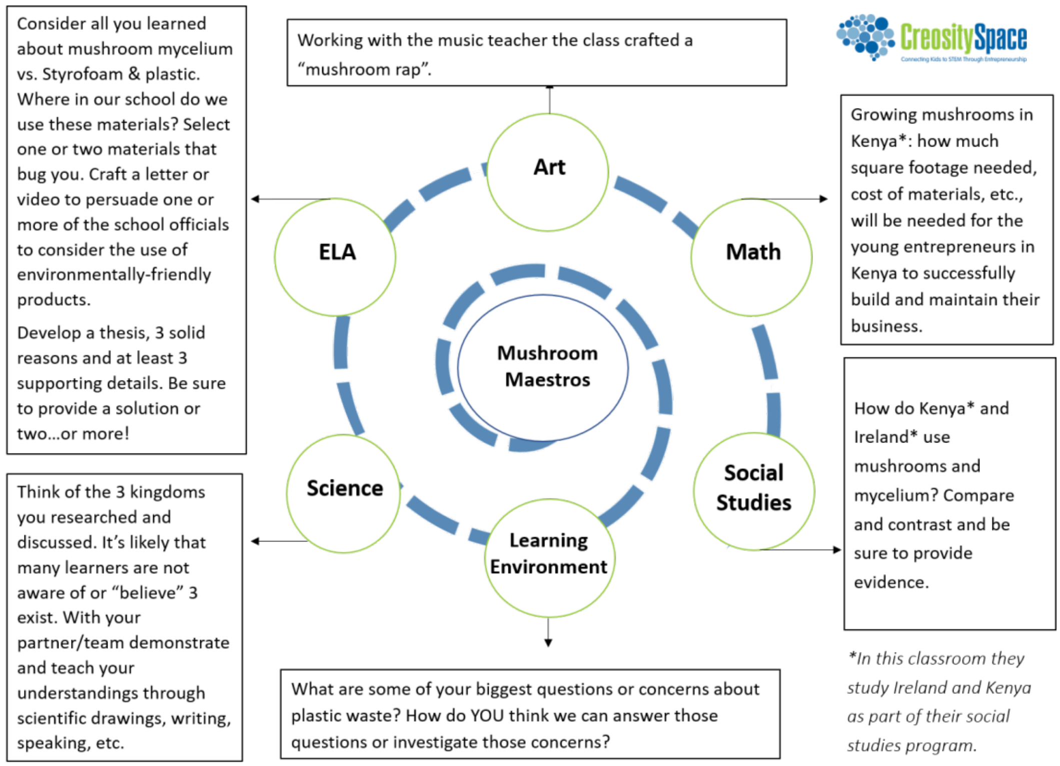
Example 2: Integration with Math

The collection, organization, and analysis of weather data (temperature, sunlight, rainfall, etc.) to be used for a science investigation supports both a variety of NGSS learning objectives (e.g., K-ESS2-1; K-PS3-1; 3-ESS2-1; 5-ESS1-2) and gives students motivation to practice necessary math skills (K.CC.7; K.MD.3,4; 5.MD.2; 5.G1,2).

The CreositySpace Approach

In order to address this challenge, **nearly 50 percent of CreositySpace lessons are suitable for instruction during ELA, social studies, math, or art classes.** While these lessons can certainly be delivered during science instructional time, they are intentionally designed to reinforce key ELA, math, social students and art learning objectives, in addition to teaching the intended science concepts. To help visualize lesson integration an organization spiral accompanies every unit, as well as examples of spirals teachers have used in their own classroom. An example series from the grade 3 unit *Mushroom Maestros* is provided below





Integration spiral from a grade 3 classroom in Upstate New York.

TIP #4 - Nature of Science: Scientific Knowledge is Open to Revision with New Evidence: Things Aren't Always As They Seem

Things aren't always as they seem as the Indian parable, *The Blind Men and the Elephant*, demonstrates. The process is similar with the accumulation and evolution of scientific knowledge.

As we are able to make more and more direct observations, we develop a better overall picture of a given concept or phenomenon. For example, new fossil discoveries in Antarctica are changing what we know about the geological and biological history of that continent-- humorously illustrated by paleontologist Brandon Peecook when he said, "The more we find out about prehistoric Antarctica, the weirder it is."

New developments in scientific understanding aren't limited to just the past. In the last decade alone, we have made significant advances in our understanding of the universe—e.g., the composition of planets in our solar system and black holes—and the structure of matter to more accurately measure things such as mass, current, and temperature, and in biology where discoveries are fueling new ways to fight cancer and diseases. Each of these giant steps forward in understanding was preceded by *countless experiments and observations, as well as a general open-mindedness to developing new hypothesis and, ultimately, new conclusions.*

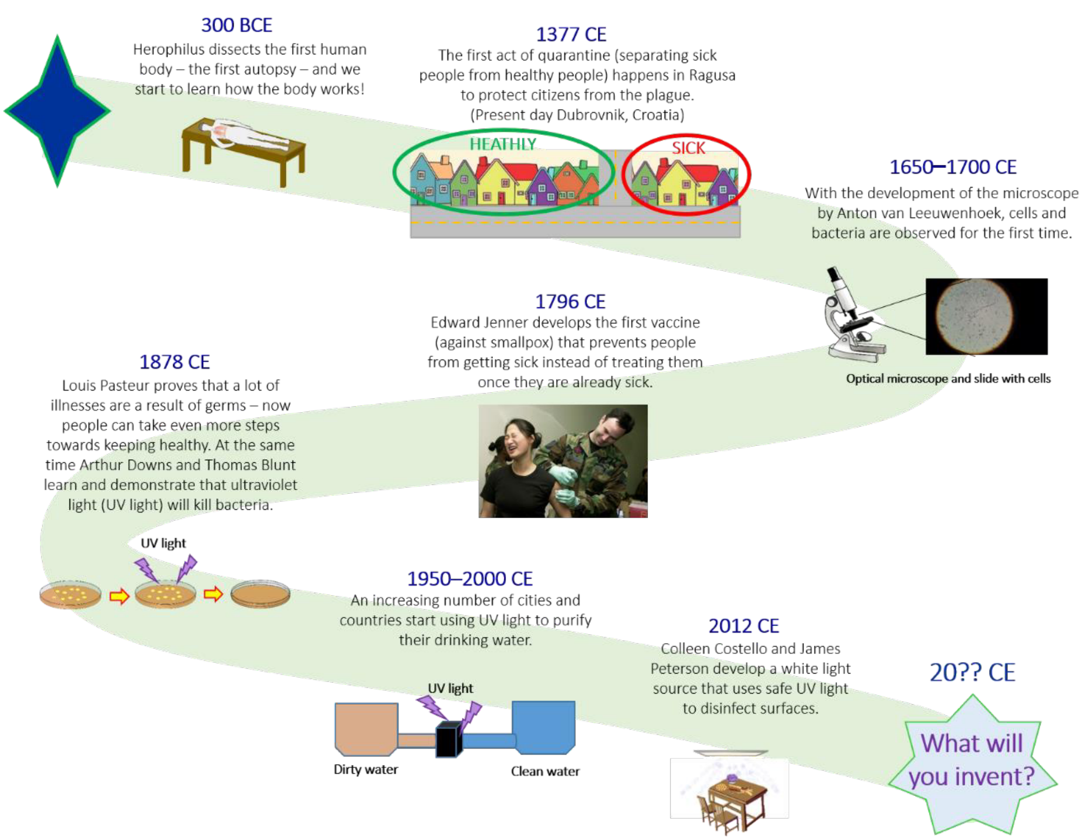
The CreositySpace Approach

So how does CreositySpace bring this concept into the elementary classroom—when there are already plenty of facts students need to learn? CreositySpace highlights both the past and the future!

In addition to highlighting one or more cutting-edge technologies in every CreositySpace unit, and how the entrepreneurs and scientists behind those technologies use new information and discoveries to change what we know and do, each unit contains a Technology Historical Timeline. This timeline illustrates how changes in our understanding of a certain topic have gotten us to where we are today. With these concrete examples of past, present, and future, students can connect the things they are learning to the bigger, and more nebulous, concept of Scientific Knowledge.

For example, the timeline pictured below--from the *Contagion Crushers* unit--illustrates some key steps the progression of our understanding around illness, germs and community health.

Image on the left: Colleen Costello is the co-founder of Vital Vio and featured entrepreneur in Contagion Crushers. They have developed a disinfectant lighting technology that kills bacteria but is safe for humans. The technology is already being used in schools and hospitals.

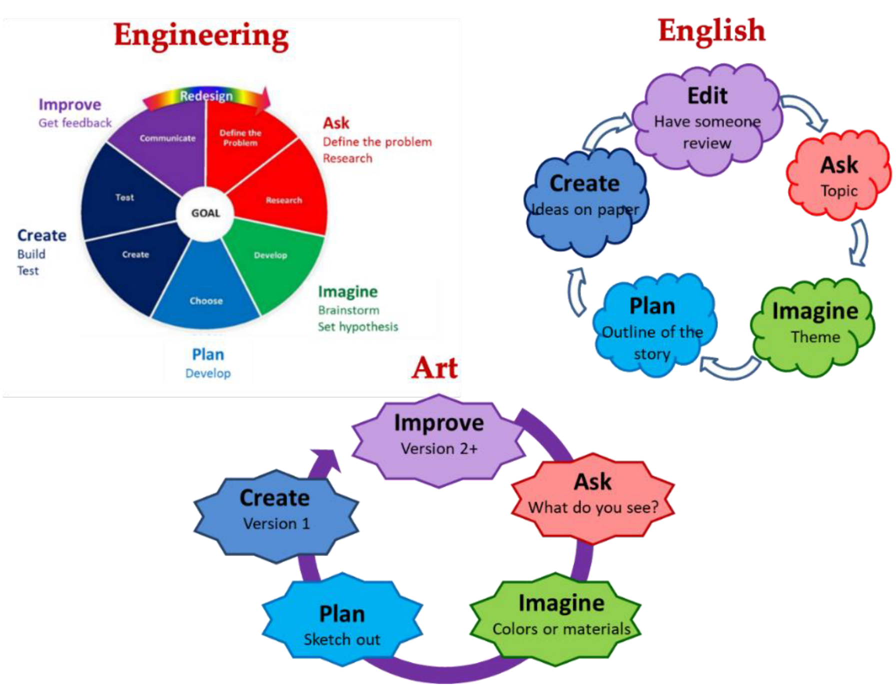


TIP #5 - The Engineering Design Process: Hiding In Plain Sight - The Engineering Design Process The Tool You Use Without Knowing It

Despite what the name might suggest, the engineering design process (EDP) is not any different than the creative or iterative process. In fact, you follow the same basic steps in the EDP as you do if you are writing a story or painting a picture.
Those steps require you:

- Step 1: Start with a question, problem, or goal. Define constraints and criteria for success.
- Step 2: Think about all the possibilities—a.k.a., brainstorm.
- Step 3: Decide which ideas from the brainstorming you want to use.
- Step 4: Create your first draft, prototype or version.
- Step 5: Get feedback and improve your design, story or picture.

While the words used to describe a step might be different, the general goals of each step are the same. The engineering design process is an integral part of inquiry-based learning and present throughout the Next Generation Science Standards (NGSS)

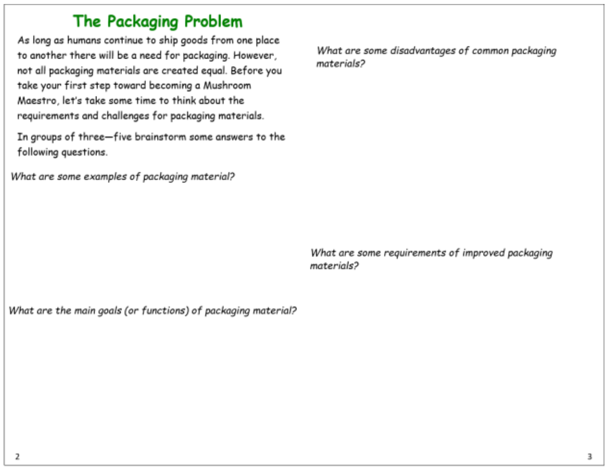


The engineering design process is most effective when students are active participants in each step, rather than following a rigid set of instructions or directions. *While this doesn't mean the process must be 100% flexible, it does mean* ***there must be room*** *for student input along the way.* The table below outlines some examples on how to include student participation in each step.

STEP	Methods for increasing student participation
1	• Introduce the overall problem to the class **with** a group discussion about WHY the problem is important, what the constraints might be, and what features a solution would need. • Have students explain why they think a certain feature (or design criteria) is important. • As a class choose a final list of constrains and design criteria.
2, 3	• Have students think of and share ideas around what things they can use in their experiments or designs. • If there are things they MUST use, that's OK, just allow them to have some choice to add at least one new option to the mix. • Resist providing detailed *instructions* on how to complete a challenge or investigation. Instead provide general guidelines and have team pick from their ideas for the detailed solution.
4	• If possible, allow students to choose how they demonstrate their knowledge—for example this could be a video versus something written. • If the output form is fixed, e.g., they must build a prototype or submit a detailed drawing, let them determine the materials they can use (e.g., a design can be done in pen, pencil, crayon, color pencils, paint, etc.).
5	• Connect evaluation and feedback to the selected criteria. • Let students propose their own testing plans. • Have students provide peer-feedback as well as receiving teacher feedback. • Ask them to provide you feedback on the overall project.

The CreositySpace Approach

CreositySpace units have a broad range of lesson scaffolding designed to facilitate student input. In many cases each step begins with a group discussion to identify specific student ideas and interests which can be incorporated. While the detailed teacher lesson description clearly indicates what must be accomplished in each step to adequately address the standards, there is flexibility in how they choose to accomplish that goal. These details can be determined by student interests identified during the preceding discussion. Two examples—one from *Mushroom Maestros* (grade 3) and one from *Green Architects* (grade 2)—are provided below.



The Packaging Problem

As long as humans continue to ship goods from one place to another there will be a need for packaging. However, not all packaging materials are created equal. Before you take your first step toward becoming a Mushroom Maestro, let's take some time to think about the requirements and challenges for packaging materials.

In groups of three—five brainstorm some answers to the following questions.

What are some examples of packaging material?

What are the main goals (or functions) of packaging material?

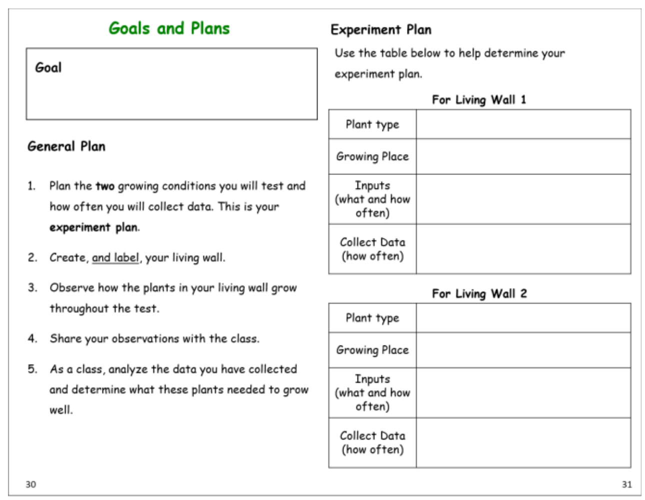
What are some disadvantages of common packaging materials?

What are some requirements of improved packaging materials?

2 3

Left: Excerpt from the **Mushroom Packaging** design challenge in *Mushroom Maestros*. Students begin with a class wide discussion on common packaging—the function, the issues, and requirements for an improved packaging material. Students use the design challenges and performance criteria they identify in this discussion to evaluate the materials they develop during the design challenge.

Right: Excerpt from **The Wall is ALIVE!** investigation in *Green Architects*. Students must perform experiments to gather data and support the conclusion that plants need light and water to grow. Students are given the opportunity to determine some of the testing conditions—so that they develop ownership in the experiment—but the teacher still has the final authority to make sure a suitable range of conditions is chosen to enable students to determine that light and water are required.



Goals and Plans

Goal

General Plan

1. Plan the **two** growing conditions you will test and how often you will collect data. This is your **experiment plan**.
2. Create, and label, your living wall.
3. Observe how the plants in your living wall grow throughout the test.
4. Share your observations with the class.
5. As a class, analyze the data you have collected and determine what these plants needed to grow well.

Experiment Plan

Use the table below to help determine your experiment plan.

For Living Wall 1

Plant type	
Growing Place	
Inputs (what and how often)	
Collect Data (how often)	

For Living Wall 2

Plant type	
Growing Place	
Inputs (what and how often)	
Collect Data (how often)	

30 31

TIP #6 - Crosscutting Concepts: Patterns: Order Out Of Disorder

Students start recognizing and organizing patterns from the time they are infants. Pattern recognition is so much a part of human nature that many of us don't even recognize we are engaged in it. If we highlight patterns as a scientific fundamental, it provides a great opportunity for students to see the scientist in themselves from an early age.

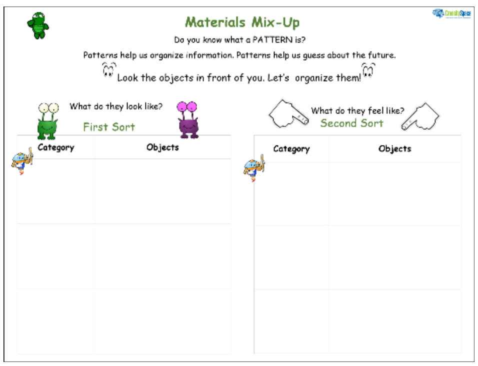
The Second Law of Thermodynamics states, in a simplified way, that the universe naturally tends toward increasing disorder. While this statement might be a hard idea for adults to understand—let alone elementary students—the simple example of a classroom becoming messy unless everyone helps to put things where they belong to keep it neat is a relatable real-world illustration of this Law.

- The concept that the natural state of the universe is messy and disordered makes patterns and pattern recognition very fundamental to scientific investigations.
- The presence of patterns tip us off to <u>what</u> things might be connected.
- The nature of patterns give us insight into <u>how</u> things might be connected.

This is why identifying, working with, and understanding patterns is so fundamental to science instruction and the first of the crosscutting concepts (CCC). Patterns are also a great way to connect science and engineering to other disciplines like math and art. The related science and engineering practices (SEPs) of Analyzing and Interpreting Data and Using Mathematics and Computational Thinking serve as a bridge between the different dimensions of the NGSS and into many math learning objectives. The identification of patterns in shapes—snowflakes, rainbows, a bee's honeycomb hive—naturally connect science, art, and engineering.

The CreositySpace Approach

The identification and use of patterns are so fundamental to real world science and engineering that they show up in nearly every CreositySpace unit regardless of the specific standards being addressed. When students are analyzing data or looking for common themes in nature, they are working to articulate a pattern that describes their observations and underlying phenomenon. Below we outline examples from three of our units: Polymer Prodigies (grade 2), Mushroom Maestros (grade 3) and Circuit Creators (grade 4).


Materials Mix-Up

Do you know what a PATTERN is?

Patterns help us organize information. Patterns help us guess about the future.

Look the objects in front of you. Let's organize them!

What do they look like? First Sort

Category	Objects

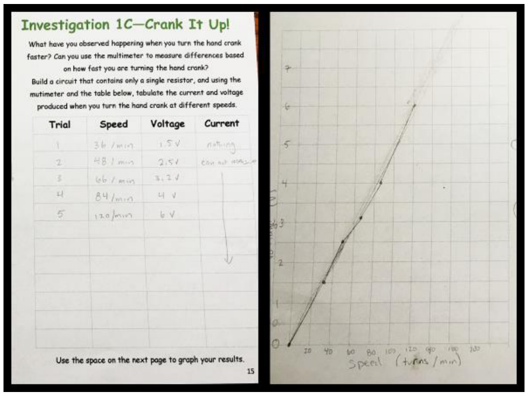
What do they feel like? Second Sort

Category	Objects

Left:

In the "Materials Mix-Up" introductory activity associated with *Polymer Prodigies*, students must identify and describe patterns in the physical properties of common objects. This investigation expands throughout the unit as students begin to connect physical properties of an object to its suitability for different tasks.

Right: In *Mushroom Maestros* students are asked to organize a variety of living organisms according to the similarities or patterns they find in "Who Are You Most Closely Related To?" sorting activity. Even though the sorting categories are left up to the student, the discussion easily sets the stage for a broader exploration of traits and characteristics including the similarities and differences between parents and offspring.



Right: In *Circuit Creators* students explore circuits, LEDs, and electricity generation using bread board and hand cranks generators. To help them better understand how energy is transferred from one place to another they look for patterns in the relationship between electrical energy (represented here as voltage) and mechanical or physical energy (represented here by the hand crank turns per minute).

TIP #7 - The Nature of Science: Science Is a Human Endeavor: Scientists are Regular People Too

While no one would dispute the human connection and motivation of our frontline healthcare workers—nurses, doctors, mental health professionals—the current pandemic also shines light on the human connection to science that drives so many individuals working in STEM fields—scientists and engineers—to provide new innovations and solutions to their communities. Examples include:

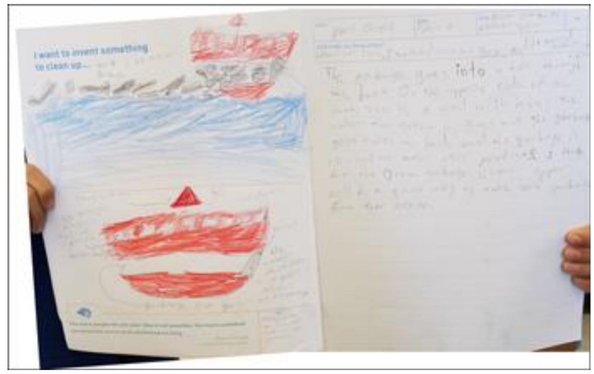
- Precision Valve and Automation near Albany, NY, designed, built, and started manufacturing a simple ventilator that could be used to keep people alive in an emergency situation. Read more here.
- Giants like Dyson and GM are leveraging their own expertise and partnering with other companies, such as Ventec north of Seattle, WA, to increase the production of standard ventilators. Read more here and here.
- Everyday scientists, engineers and innovators are using their design skills and 3D printers to help supply hospitals with lifesaving personal protection equipment (PPE). Take a look at a this video and these articles from the 3D printing community here, here and here.

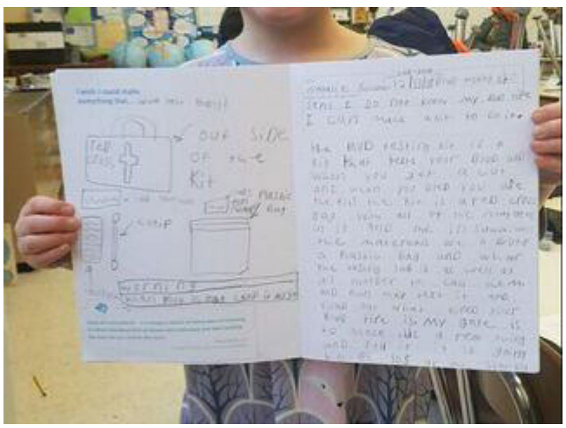
The CreositySpace Approach

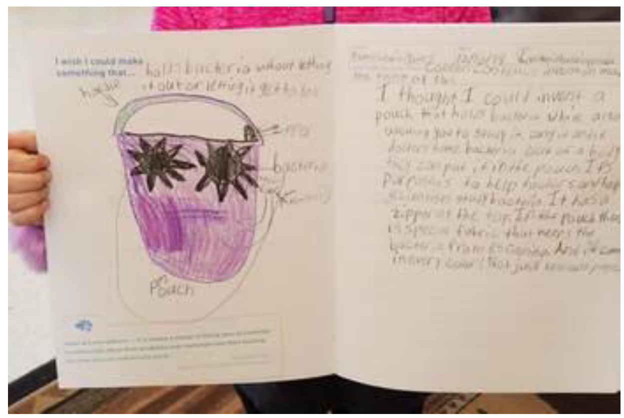
Science truly *is* a human endeavor and why every CreositySpace unit features a number of STEM entrepreneurs. In every instance, their technology innovations and businesses highlight the community need that drives their motivation. This motivation or inspiration is important to engaging more students in science at a young age when they are naturally curious and creative.

CreositySpace units and kits go a step further and encourage each student to see themselves as the innovators—to explore the needs they see around them every day and to design solutions. This process comes to life with the Book of Ideas, a young inventors journal that encourages students to design solutions to problems that matter to them with innovation prompts such as:

- I want to invent something to clean up…
- This would help someone who is sick…
- I wish I could make something that…
- I want to make a difference by…







TIP #8 - Science and Engineering Practices: Math & Computational Thinking: Beyond the Numbers: Using Math & Computational Thinking Every Day

We all probably know someone who has said they are “no good at math” or “ not a numbers person," but then turns around and creates a beautiful quilt (geometry), bakes a stunning dessert (ratios), or plays a beautiful piece of music (patterns, time, frequency, arrays). What about when we’re teaching kids to share (ratios), or what is “fair” (equivalence), or how to put away the game so that every piece fits back in the box (geometry again)? Math is everywhere!

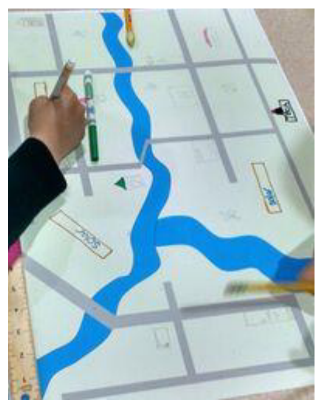
We use math and computational thinking more often than we realize, yet rarely identify it as such outside a traditional math or computer science lesson. Imagine the potential if every student could say with confidence that “they were good at math” or that they were, in fact, “a numbers person,” even if they struggled with arithmetic or their multiplication tables? The beauty of math is that it is everywhere, so let’s bring it into the forefront and let it shine!

The CreositySpace Approach

Just as math and computational thinking can be found throughout our daily lives, each CreositySpace unit is full of opportunities to see them in action. The hands-on investigations have students measuring, mixing, arranging and analyzing.

Students measure, mix, and weigh during the [Mushroom Maestros] mushroom packaging investigation.

The focus on invention, entrepreneurship, and their community have students making links between the skills they use in their technical classes (math and science) and the skills they use to form arguments and explanations in their non-technical classes (ELA, social studies, art).



L: Slides from the Makerspace Challenge unit. Students must consider things like market size, the cost of using different materials, and the value of various product features.

R In *Community Designers* students must consider space, community needs, and budget when designing their neighborhoods.

And finally, the explicit math problems in each unit connect specific math standards to the real-world applications they are learning about.

TIP #9 - Science and Engineering Practices: Engaging in Argument from Evidence: Evidence-Based Arguments: More Than Just a Scientific Skill

Despite what a lot of young minds (and a few older ones) might think, science is less about "knowing with absolute certainty" and more about "figuring out the most reasonable explanation given the existing evidence". This is why it is so crucial that students have exposure to and practice using the Scientific and Engineering Practice of Engaging in Argument from Evidence right from the very beginning.

Contentious title aside, Engaging in Argument from Evidence, along with Asking Questions and *being* Open to Revision in Light of New Evidence, are core tenents of critical thinking and the pursuit of knowledge—scientific or otherwise. Being able to evaluate a theory or explanation, articulate the supporting—or refuting—facts and observations, and understand the difference between evidence and opinion, are skills that benefit all members of society. ***And they are skills that we must enable our students to practice every day.***

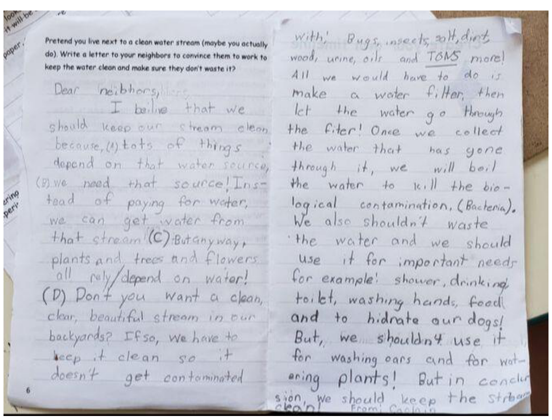
Not only does this support the development of the whole student, but it teaches young learners that science is about searching for answers from the available information vs. memorizing—or knowing—a bunch of facts.

The CreositySpace Approach

Throughout CreositySpace units, students are asked to propose an explanation or a solution to a given scenario and then to justify their answer based on what they read, observed, researched, or experienced. Emphasis is placed on identifying rational connections between evidence and explanations to help students learn the difference between unsupported opinions and logical conclusions. A few examples from the *Water Watchers* unit are described below.

One of the major investigations in this unit is a water filtration experiment in which students must design, and redesign, a water filter based on an agreed set of criteria. As groups test out the performance of their design they must discuss and propose design changes based on their observations, or the evidence, from previous trials.

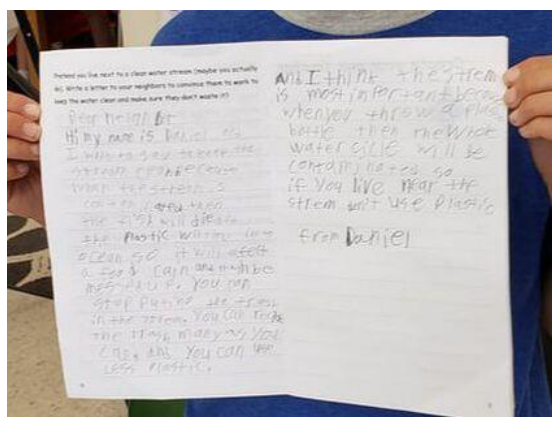
The translation of the skill into other subject areas is a component of many cross curricular activities found throughout each unit. This provides both an opportunity for additional practice of this “science” standard while also reinforcing the deeper connection between “science skills” and “ELA skills”. For example, one writing activity asks students to write a letter to their neighbor on why they should protect a nearby stream.



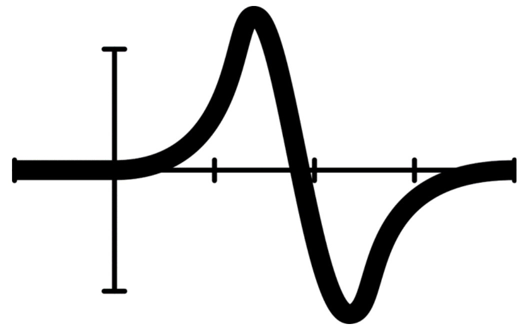
Pretend you live next to a clean water stream (maybe you actually do). Write a letter to your neighbors to convince them to work to keep the water clean and make sure they don't waste it?

Dear neibhors,
I beilive that we should keep our stream clean because, (A) lots of things depend on that water source, (B) we need that source! Instead of paying for water, we can get water from that stream (C) But anyway, plants and trees and flowers all rely/depend on water! (D) Don't you want a clean, clear, beautiful stream in our backyards? If so, we have to keep it clean so it doesn't get contaminated with: Bugs, insects, salt, dirt, wood, urine, oils and TONS more! All we would have to do is make a water filter, then let the water go through the fiter! Once we collect the water that has gone through it, we will boil the water to kill the biological contamination. (Bacteria). We also shouldn't waste the water and we should use it for important needs for example: shower, drinking, toilet, washing hands, food and to hidrate our dogs! But, we shouldn't use it for washing cars and for watering plants! But in conclusion, we should keep the stream clean!

6



TIP #10 - Crosscutting Concepts, Science and Engineering Practices: Systems, System Models, Developing and Using Models: Nothing Is Ever as Simple As It Seems



The world is made up of many complicated and interdependent systems that are difficult—or nearly impossible in some cases—to understand fully. This can be intimidating for young learners who might feel they must, or should, know about every part of a system or concept. Enter *the model*. **More than just a "make work" activity or art project, models are a powerful tool to increase student confidence, personalize learning, and help students develop a deeper understanding of a given phenomenon, concept, or system.**

Student Confidence and Personalization

The first step any scientist or engineer takes when developing or using a model is to define the boundaries—the model takes into account a, b, and c but does not include d, e, or f. Translating this to the student mind—the clear setting of limits and the explicit statement of the model's limitations—illustrates that the model is not expected to be perfect nor explain every single thing component. For many students, this can be **a powerful anchor that allows them to stay focused on the key concepts and "let go of" other parts of the system that aren't important at the moment.**

On a more subtle level, working with models let students know that it is OK to make approximations—a model is, by definition, an approximation of a larger system. It also **gives them an opportunity to internalize the idea that science isn't about getting things right the first time—as models are meant to be revised through the course of their lifetime or, in this case, throughout the unit.**

Finally, **models give students an opportunity to express their understanding in a way that works for them.** Not only does this provide validation for their way of thinking, but it provides a natural chance for personalization.

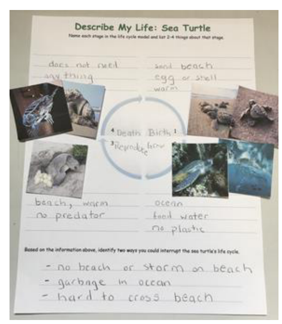
Deeper Thinking—Deeper Connections

In the real-world models are used to help scientists and engineers figure out where to start, what to try next, and what results they might expect for a given set of test or environmental conditions. In the classroom, **models are powerful tools because they give students a framework with which to apply what they have been learning to a new scenario—taking their learning and understanding to a deeper level.**

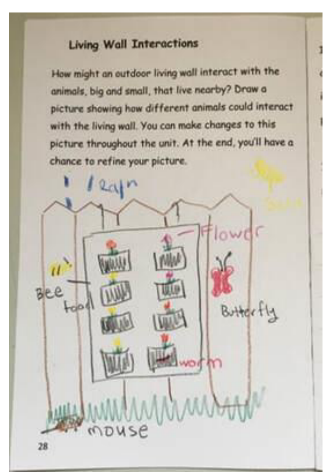
The CreositySpace Approach

In the CreositySpace units models are generally developed throughout the first two-thirds of a unit and then used by the students as a tool to help them apply what they learned to a more involved summative challenge.

For example, in the grade 3 unit, *Contagion Crushers*, students study and develop life cycle models which they must then use to determine how to support or hinder growth of a given organism.



In the grade 2 unit, *Green Architects*, students use their living wall interactions models to help design and explain their green buildings.



TIP #11 - The Nature of Science: The Other Side of the Coin

Three-dimensional learning is a foundational pedagogical concept derived from the NRC Framework for K-12 Science Education (the Framework). The three dimensions--Science and Engineering practices (SEP), Disciplinary Core Ideas (DCI), and Crosscutting Concepts (CCC)--are described as complementary but distinct practices.

Flowing from these practices, the Performance Expectations (PE) were positioned as a hyper-tactical way to measure student understanding of the three dimensions. There remains a final category, however, the Nature of Science (NOS), which looks like it should be its own dimension but is not. Instead, it is split and positioned below both the Science and Engineering Practices as the Crosscutting Concepts. What gives?

Performance Expectations		
Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking questions / defining problems Developing and using models Planning and carrying out investigations Analyzing and interpreting data Using math & computational thinking Constructing explanations/designing solutions Engaging in argument from evidence Obtaining, evaluating, and communicating information *Connections to Nature of Science* Scientific investigations use a variety of methods Scientific knowledge is based on empirical evidence Scientific knowledge is open to revision in light of new evidence Science models, laws, mechanisms, and theories explain natural phenomena	ESS1.A The universe and its stars ESS1.B Earth and the solar system ESS1.C The history of planet Earth ESS2.A Earth materials and systems ESS2.B Plate tectonics and large-scale system interactions ESS2.C The roles of water in Earth's surface processes ESS2.D Weather and climate ESS2.E Biogeology ESS3.A Natural resources ESS3.B Natural hazards ESS3.C Human impacts on Earth systems ESS3.D Global climate change LS1.A Structure and function LS1.B Growth and development of organisms LS1.C Organization for matter and energy flow in organisms LS1.D Information Processing LS2.A Interdependent relationships in ecosystems LS2.B Cycles of matter and energy transfer in ecosystems LS2.C Ecosystem dynamics, functioning, and resilience LS2.D Social interactions and group behavior LS3.A Inheritance of traits LS3.B Variation of traits LS4.A Evidence of common ancestry and diversity LS4.B Natural selection LS4.C Adaptation LS4.D Biodiversity and humans PS1.A Structure of matter PS1.B Chemical reactions PS2.A Forces and motion PS2.B Types of interactions PS2.C Stability & instability in physical systems PS3.A Definitions of energy PS3.B Conservation of energy and energy transfer PS3.C Relationship between energy and forces PS3.D Energy in chemical processes and everyday life PS4.A Wave properties PS4.B Electromagnetic radiation PS4.C Information technologies and instrumentation ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and effect Scale, proportion and quantity Systems and system models Energy and matter: Flows, cycles, and conservation Structure and function Stability and change *Connections to Nature of Science* Science is a way of knowing Scientific knowledge assumes an order and consistency in natural systems Science is a human endeavor Science addresses questions about the natural and material world *Connections to Engineering, Technology, and Applications of Science* Interdependence of Science, Engineering, and Technology Influence of Engineering, Technology and Science on Society and the Natural World

In fact, the Nature of Science (NOS) is better thought of as a lens, or perspective, that gives context to the practices described by given dimension. In other words, if the top part of the SEP or CCC standard describes the "what" the Nature of Science portion provides the "why" and "how". In this way, they can be thought of **as two sides of the same coin**.

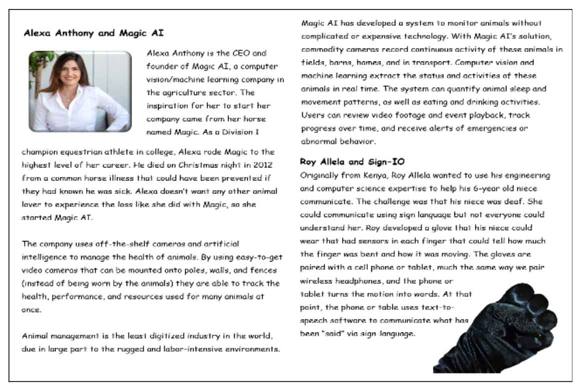
As districts work towards implementing the recommendations put forward by the Framework and associated state standards, the focus must equally address the teaching of specific skills and facts, the "what", as well as the teaching of when and where those skills can be put to use, the "why" and "how".

The CreositySpace Approach

The Nature of Science perspective provides an excellent opportunity to tailor science content so that it is real and relevant to various student populations. By connecting science content to a variety of real-world challenges and applications, CreositySpace helps students see the context within which science and engineering is put to use. The guidance and flexibility of the units enables teachers to draw upon examples that are relevant for their students so that these deeper connections can be established regardless of prior knowledge or incoming experience. A couple features common to every CreositySpace unit that help students understand the Nature of Science are listed below.

Entrepreneurs

Every unit features stories a number of real-life STEM entrepreneurs describing the challenges they are working to solve for their communities (the "why") and the innovations and businesses they are developing (the "how").



Alexa Anthony and Magic AI

Alexa Anthony is the CEO and founder of Magic AI, a computer vision/machine learning company in the agriculture sector. The inspiration for her to start her company came from her horse named Magic. As a Division I champion equestrian athlete in college, Alexa rode Magic to the highest level of her career. He died on Christmas night in 2012 from a common horse illness that could have been prevented if they had known he was sick. Alexa doesn't want any other animal lover to experience the loss like she did with Magic, so she started Magic AI.

The company uses off-the-shelf cameras and artificial intelligence to manage the health of animals. By using easy-to-get video cameras that can be mounted onto poles, walls, and fences (instead of being worn by the animals) they are able to track the health, performance, and resources used for many animals at once.

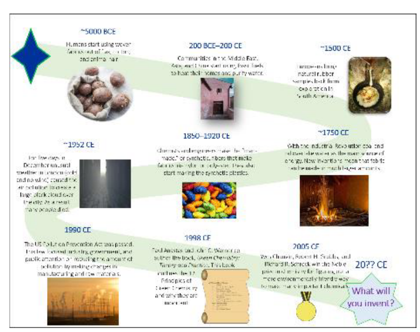
Animal management is the least digitized industry in the world, due in large part to the rugged and labor-intensive environments. Magic AI has developed a system to monitor animals without complicated or expensive technology. With Magic AI's solution, commodity cameras record continuous activity of these animals in fields, barns, homes, and in transport. Computer vision and machine learning extract the status and activities of these animals in real time. The system can quantify animal sleep and movement patterns, as well as eating and drinking activities. Users can review video footage and event playback, track progress over time, and receive alerts of emergencies or abnormal behavior.

Roy Allela and Sign-IO

Originally from Kenya, Roy Allela wanted to use his engineering and computer science expertise to help his 6-year old niece communicate. The challenge was that his niece was deaf. She could communicate using sign language but not everyone could understand her. Roy developed a glove that his niece could wear that had sensors in each finger that could tell how much the finger was bent and how it was moving. The gloves are paired with a cell phone or tablet, much the same way we pair wireless headphones, and the phone or tablet turns the motion into words. At that point, the phone or table uses text-to-speech software to communicate what has been "said" via sign language.

Technology historical timelines

Technology timelines serve many purposes. Among them, providing students with the opportunity to see and learn about how scientific understanding has evolved over time—including which theories have been proven wrong or which concepts formed the foundational understanding for what we know today.



Use of real-world scientific equipment

As much as possible, CreositySpace units employ the same scientific equipment scientists and engineers are using in the field. This includes using components like breadboards, LEDs, resistors and multimeters when working with circuits (*Circuit Creators*, *Sun Catchers*, *Battery Builders*) or working with innovative commercial products as in *Mushroom Maestros* and *Community Designers*.

While the Nature of Science might seem of lesser status within the NGSS when compared to the SEPs, DCIs, and CCCs, it is an incredibly powerful tool to help your students connect to, and identify with, what they are learning.

TIP #12 - Crosscutting Concepts: Sizing Up Scale and Proportion: Understanding the Very Big and the Very Small

Trillion-dollar budgets, microscopic viruses, geological time frames. Understanding the very big and the very small can be challenging even for adults. *So how do you make the too big, or too small, visible—and understandable*—to students who might have trouble understanding the difference between driving to the next state versus driving across the country? *The key: tangible connections and repeated exposure.*

While any instruction on scale, proportion and quantity must begin with the traditional bigger vs. smaller, hotter vs. colder, younger vs. older, it must quickly progress to include the very big, the very small, the very old, the very slow, etc., so students begin, at a young age, to get comfortable with the notion that scale and quantity span a tremendous range.

To do this, students need bridges connecting quantities they can see and touch to the more nebulous concepts they are learning. For example, it's hard to understand that air is full of tiny gas particles we can't see, but it's easier to understand that air is more than "nothing" when you see the wind blowing leaves around. Additionally, students need to think about—and use—these connections over and over again. This helps them to get comfortable with quantities and concepts they cannot see or fully understand.

Tangible

The first step is to make real connections between different quantities. These can take the form of going from something students can see and feel—like a sugar cube—to something a bit smaller yet still visible—a pile of sugar—to something too small to see—individual sugar particles (molecules) dissolved in water. This type of investigation helps students "see" something that is too small to see. Working backwards along the quantity scale (e.g., evaporating the water so that you have sugar grains again), will help students make even deeper connections between the "seen" and "unseen."

Repetition

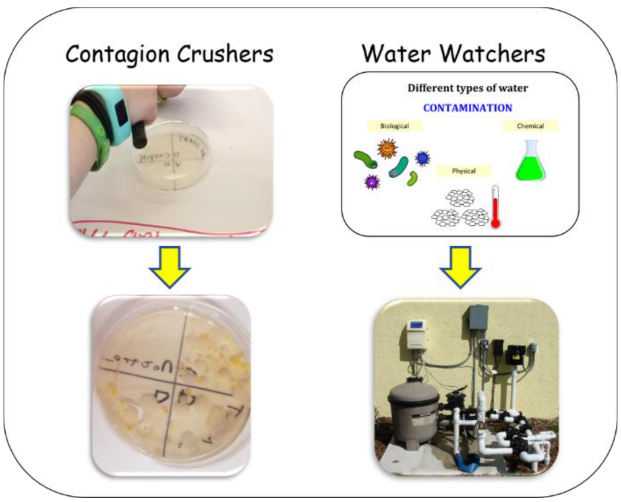
While students can't see the dissolved sugar particles described in the dissolution demonstration above, it gives them experience, and *a bridge, connecting matter they can see with matter that is too small to be seen*. On its own, this example is not nearly enough for students to understand the existence of the small sugar particles. However, when coupled with other examples of things too small to see, they will begin to gain an appreciation for that end of the size spectrum. Repeated exposure to an idea is a requirement for developing a deep understanding of any concept, but it is especially important for students as they try to understand the meaning behind quantities they cannot measure directly.

The CreositySpace Approach

CreositySpace units contain the traditional instruction around scale, proportion, and quantity. Students are constantly measuring and comparing (analyzing) concepts such as speed, size, distance, and more. **Many units take this instruction to the next level through the type of bridge building and repetition described above.**

A number of unit examples are outlined below.

Contagion Crushers: In this unit students grow microbes that they have collected from surfaces around the room. Initial the microbes are too small to see but over the course of a week the microbes grow to a size that is clearly visible to the human eye.



Grade three unit sequencing: *Contagion Crushers* and *Water Watchers*

In our Grade 3 sequencing students have multiple opportunities to increase their familiarity with microscopic organisms. They are first introduced to microorganism when they grow and study microbes in *Contagion Crushers*. They are given a second opportunity to study microbes when they discuss different types of water contamination--and the resulting purification requirements--in *Water Watchers*.

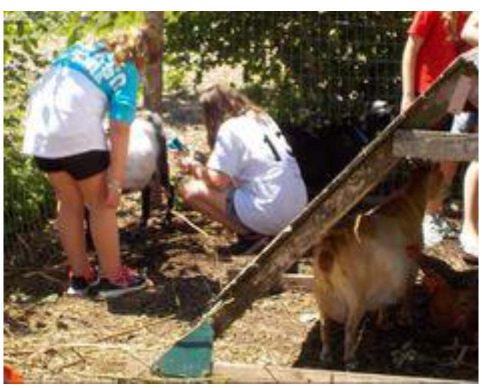
Technology Historical Timelines

Every CreositySpace unit contains a Technology Historical Timeline which helps students develop an appreciation for the timescale associated with human civilization.

TIP #13 - Role Models: You Can't Be What You Can't See: Looking at STEM Through the Lens of Student Interest

"You can't be what you can't see," has become somewhat of a mantra in the promotion of diversity and inclusion—especially in the fields of science, technology, engineering and math (STEM). Numerous reports support the benefits of young students seeing people who look and sound like them, expressing an interest in STEM and pursuing STEM-based careers. Typical lenses by which we view diversity include race, gender, socio-economic background, physical or cognitive ability, etc. Less typical, but equally important, is the lens of student interest.

Even at a young age, students classify their interests as "STEM-related" (e.g., robotics, coding, engineering), "arts-related" (e.g., drawing, music, reading, writing), or "social-related" (e.g., sports, storytelling, fantasy creation). Student's whose interests could be described as "arts-related" or "social-related" often view themselves as non-STEM individuals. This self-perception is easily reinforced in and outside of school, and students often grow increasingly disconnected from STEM and innovation communities.



However, the overlap between what is traditionally considered a "STEM pursuit" and what is traditionally considered a "non-STEM pursuit" is greater than one might think. For example, the use of statistics and statistical analysis (math) in baseball is impossible to avoid, as is the discussion around the use of wood or aluminum bats (materials science). The amount of chemistry in fine arts—from colors and drying rates, to the physical properties of various media—means that many artists would probably find themselves quite adept in the lab. This overlap goes the other way too. For example, advances in innovation need people who can understand and communicate those advances and what they mean to the community or customer. Large projects with lots of moving parts need creative and experienced project managers to make sure that people have the information and materials to get the job done.

As we work to improve the diversity in STEM—to show every learner that there is a place for them in the STEM community—we must keep our eyes and minds open to all the different forms that can take.

The CreositySpace Approach

Every CreositySpace unit features a number of STEM entrepreneurs, their technology innovations, and the businesses they are building. Some of these entrepreneurs have STEM backgrounds; others do not. Nearly every company is composed of team members with STEM-degrees and those with degrees in non-STEM fields—but everyone is an equally valuable member of the STEM-community. Presenting science to young students through the lens of innovation and entrepreneurship helps students make connections between their interests and the STEM and innovation communities. This in turn enables us to reach, and retain, students interested in STEM (science) concepts, but do not think of themselves as the archetypal scientist or engineer working alone in the lab. A few examples are outlined below.

Stacy and Christopher, Co-founders at Evrnu:

As a kid, Stacy didn't think that she was any good at science. Interested in fashion and marketing, she made her way to New York City's Fashion Institute of Technology for college. There she discovered her interests in fashion translated into skills in the lab--although she still preferred marketing and business development side of the industry. As CEO Stacy is primarily responsible for the business development activities, while Christopher oversees the technology development.

Jason and Jared, Co-founders at ZILA Works:

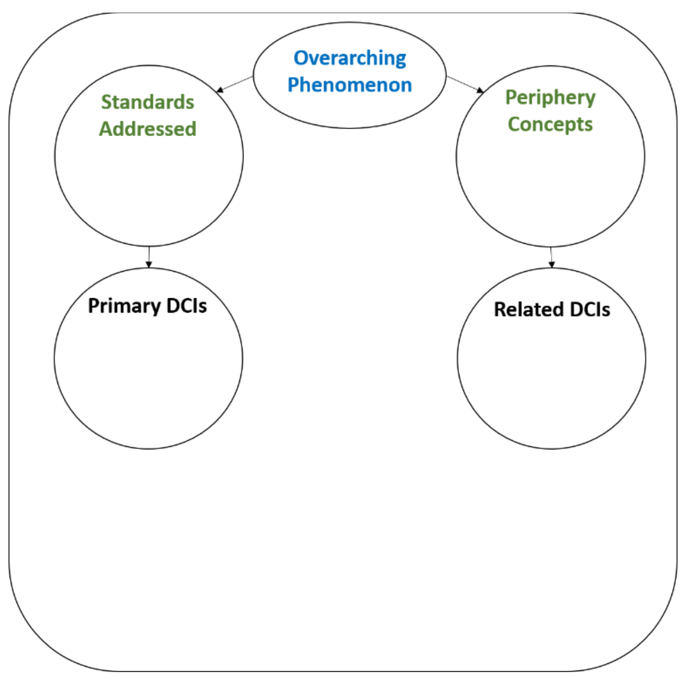
Jason (second from the right) and Jared (far right) have always been interested in sustainability and community structure. For Jason that lead him to study zoology and economics while Jared pursued studies in history. The two met in business school, through their shared interest in sustainable business development. ZILA Works was born from their shared interest in creating a company that could unite farmers, factory workers, and consumers looking for more responsible materials and environmentally friendly products.

TIP #14 - Disciplinary Core Ideas: Connecting the Dots with the DCIs

In the real-world scientific exploration is rarely isolated in one of the physical, life, Earth and space, or engineering **topic silos**. Indeed, it is a goal of the NRC *Framework for K-12 Science Education* that curriculum units combine two or more of these topic silos for any given unit. Additionally, if we want to teach students about science and engineering using authentic and engaging phenomena, we will likely find ourselves touching upon concepts that fall outside of the main focus of the unit.

For example, a grade 5 unit aimed at teaching students about the **properties of materials** might use the example of recycling as a discussion topic. This topic will require teachers to introduce **periphery** concepts around **energy** and **environmental impact**. These periphery concepts (energy and environmental impact) are not necessarily part of the primary learning objective but are critical to making the lesson authentic and relevant to the students.

Inclusion of periphery concepts can create a challenge for teachers as they try to determine the best way to facilitate the discussion without getting too far afield or overwhelming their students.

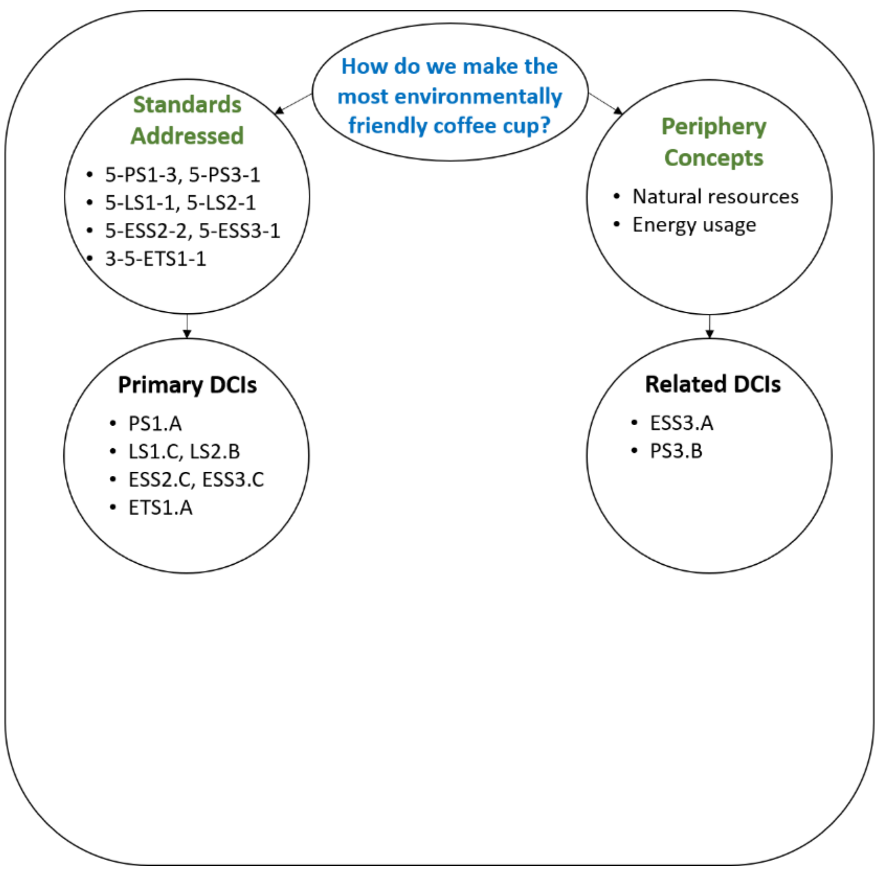


This is how the DCIs are a great asset.

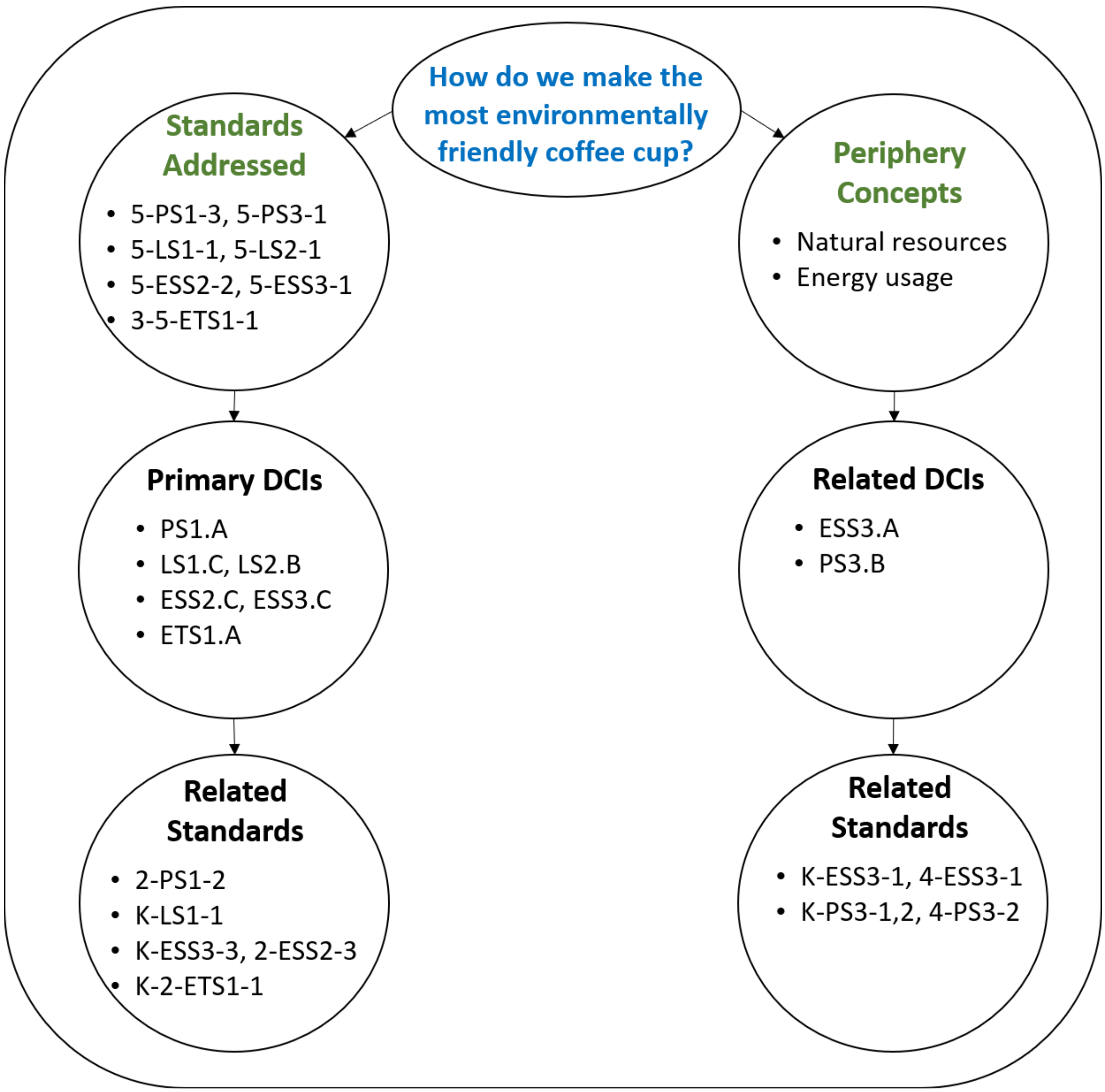
While the SEPs, PEs, and CCCs lay out the more tactical student learning objectives, the DCIs provide bigger picture connections throughout the entire learning landscape, illustrating where students have come from and where they are going in their science exploration.

Building upon the above example of a grade 5 unit on the properties of materials, we could envision the following phenomena, standards to be addressed, and periphery concepts.

- Phenomenon: How do we make the most environmentally friendly coffee cup?
- Standards Addressed: 5-PS1-3, 5-PS3-1, 5-LS1-1, 5-LS2-1, 5-ESS2-2, 5-ESS3-1, 3-5-ETS1-1
    - **Primary DCIs:** PS1.A Structure of matter, LS1.C Organization for matter and energy flow in organisms, LS2.B Cycles of matter and energy transfer in ecosystems, ESS2.C The roles of water in Earth's surface processes, ESS3.C Human impacts on Earth systems, ETS1.A: Defining and Delimiting Engineering Problems
- Periphery concepts: Natural resources, Energy usage
    - **Related DCIs:** ESS3.A Natural resources, PS3.B Conservation of energy and energy transfer

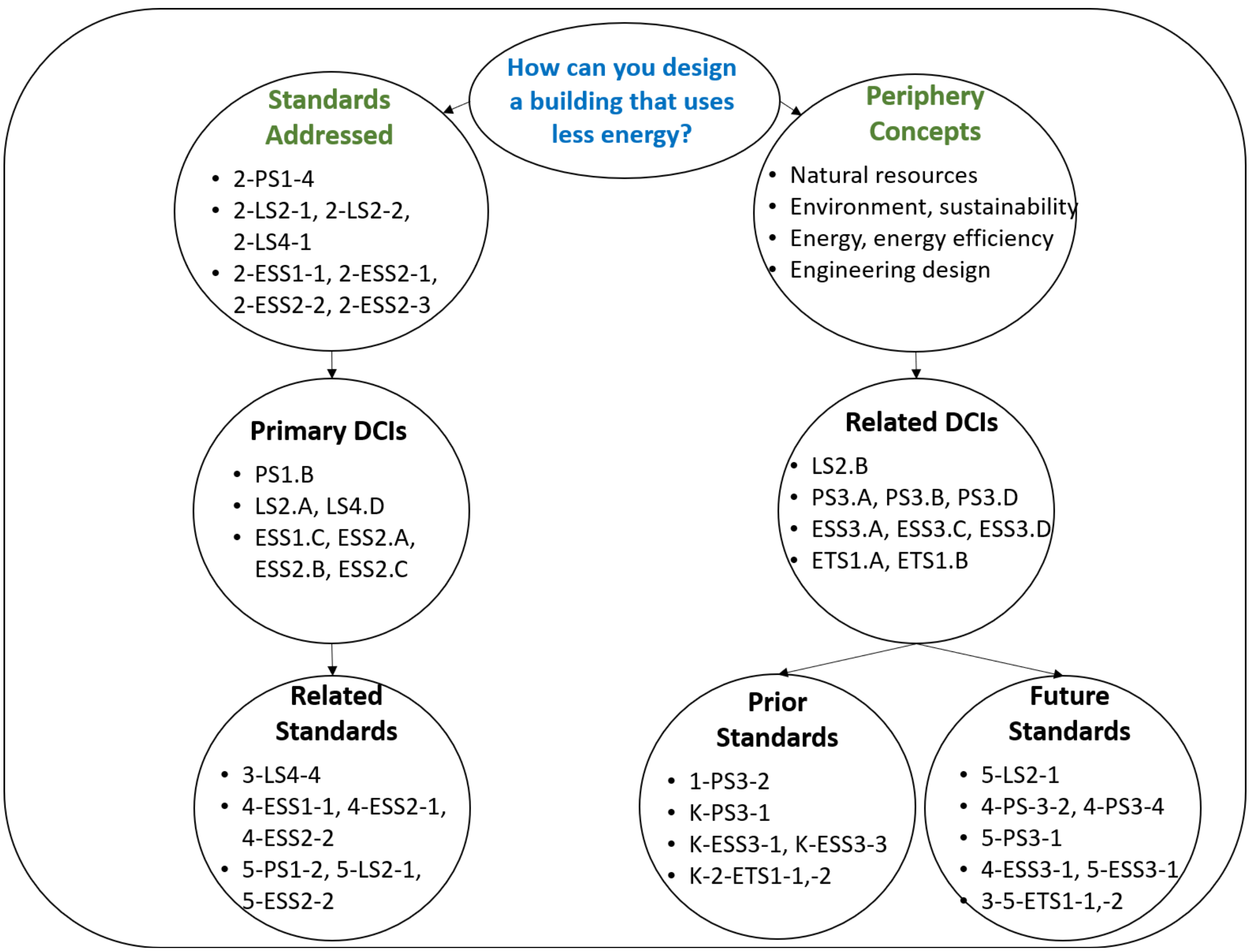


Identification of the related DCIs enables the teacher to identify the relevant past and future standards. The connections to the past let teachers frame these periphery concepts in a way that builds upon past learnings. Of course, this strategy is also applicable to the primary DCIs and helps teachers to identify critical prior knowledge required for the unit.



The CreositySpace Approach

CreositySpace units use cutting-edge STEM innovations and businesses to make the relevant science lessons *come to life* for the students. These innovations often include a number of **periphery concepts**. As a support for the teacher, each Educator Guide contains a standards table that identifies primary and related DCIs. An example from the *Green Architects* unit is provided below. (Phenomenon: How can you design a building that uses less energy?)



Performance Expectations

2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.
2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and water to grow.
2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.
[**NYSSLS**: Develop a simple model that illustrates how plants and animals depend on each other for survival.]

2-ESS1-1 Use information from several sources to provide evidence that Earth events can occur quickly or slowly.
2-ESS2-1 Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.
2-ESS2-2 Develop a model to represent the shapes and kinds of land and bodies of water in an area.
2-ESS2-3 Obtain information to identify where water is found on Earth and that it can be solid or liquid.

2-PS1-4 Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

Topic Bundle: How can we make choices that meet our needs and are better for the environment? In this bundle students explore how the choices we make can impact the world around us and that there are often options that can meet our needs while meeting or protecting the needs of plants and animals around us.

Science and Engineering Practices

Asking questions/defining problems
Activities and investigations involve asking questions and defining the information that needs to be collected in a variety of different ways.

Developing and using models
During The Wall Is Alive! students develop detailed models about the interactions between the plants and animals in a living wall. The Building a Green Building summative challenge has students modeling the different components of sustainable architecture.

Analyzing and interpreting data
During The Wall Is Alive! students are required to collect, analyze, and interpret experimental data. During the What Is Available? and What's It Like Outside? investigations students must collect information from a variety of sources and use their analysis of that information to inform their Building a Green Building summative project.

Using math and computational thinking
Connecting shapes and patterns found in nature to elements of green architecture require math and computational thinking skills. Discussions around life cycle costs and trade-offs between different materials and different design strategy require computational thinking even if no calculations are performed.

Engaging in argument from evidence
Analysis and assessment of different living wall growing conditions have students using evidence to draw conclusions. Summary tables for What's Available? and What's It Like Outside? coupled with the explanation of their final green building design have students constructing arguments based on both empirical and researched evidence.

Constructing explanations/designing solutions; Obtaining, evaluating, and communicating information
Summative project of Building a Green Building has students both designing a solution to stated challenges and communicating their design and the rationale behind it.

Connections to Nature of Science

Scientific knowledge is based on empirical evidence
Students use empirical data collected during The Wall Is Alive! to determine optimal growing conditions and to draw conclusions that plants need light and water to grow.

Scientific investigations use a variety of methods
Investigations have students obtaining information through research and experimentation.

Scientific knowledge is open to revision in light of new evidence
This topic is touched upon during the life cycle cost discussion and then again as students are asked to reflect on how opinions around building design in general have changed over time.

Disciplinary Core Ideas

LS2.A Interdependent relationships in ecosystems
LS4.D Biodiversity and humans
Living wall investigations have students exploring the importance of biodiversity, regional differences in biodiversity, and the interactions between plants and animals, especially with respect to pollination and shelter.

PS1.B Chemical reactions
Discussions around heating and cooling buildings (including heat island effects) highlight reversible temperature changes. This is contrasted by a discussion of more extreme results from high temperatures (drought, erosion, forest fires).

PS3.A Definitions of energy
PS3.D Energy in chemical processes and everyday life
Discussions about energy usage and renewable energy bring in definitions of energy and chemical processes.

ESS1.C The history of planet Earth
ESS2.D Weather and climate
The What's It Like Outside? investigation has students researching both natural hazards and general weather and climate factors to determine the design criteria for their green buildings.

ESS2.A Earth materials and systems
ESS2.B Plate tectonics and large-scale system interactions
ESS2.C The roles of water in Earth's surface processes
ESS3.A Natural resources
The What's Available? investigation has students researching and mapping a variety of natural resources (water, land, forest, etc.) as they figure out what they can use for their green buildings and what environmental factors they must consider.

ESS3.C Human impacts on Earth systems
ESS3.D Global climate change
Investigations and videos reinforce the interconnectedness between humans and all aspects of their environment.

ETS1.A: Defining and Delimiting Engineering Problems
ETS1.B: Developing Possible Solutions
All investigations have students thinking about and defining problems. The summative challenge has students designing and discussing their own green buildings.

Crosscutting Concepts

Patterns
Mapping activities (What's Available?) and weather and climate discussions (What's It Like Outside?) have students finding patterns in the natural world. Additionally, the discussion around many structural elements of green building design connect patterns found in nature to green architecture.

Cause and effect
Hands-on investigation (The Wall is Alive) have students determining cause and effect relationships between plants and their environment. The summative challenge and videos emphasize environmental cause and effect as well as the concept of balancing availability and demand of resources.

Systems and system models; Energy and matter: Flows, cycles, and conservation
Both The Wall Is Alive investigation and the Building a Green Building summative challenge have the students working with model systems to illustrate larger scale ecosystem interactions (The Wall Is Alive!) and energy and natural resource management (Building a Green Building).

Structure and function
Living wall investigation (The Wall is Alive) and other green building elements connect and demonstrate structure and function in both the natural world and the human-made world.

Stability and change
By studying how a building must protect those inside from the outside elements (What's It Like Outside?, Which Is Better? You Decide!), students evaluate how the weather and climate changes on both a short and long timescale.

Connections to Nature of Science
Science is a way of knowing; Science addresses questions about the natural and material world
Videos and introduction text give support these connections.

Science is a human endeavor
Entrepreneur stories and historical timeline highlight the human aspect of science and engineering.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology; Influence of Engineering, Technology and Science on Society and the Natural World
Introduction text, historical timeline, entrepreneur story and activities highlight above interactions and interdependencies.

Connections to Common Core State Standards
See previous Common Core Standards section for ELA and Math standards addressed by these activities.

TIP #15 - Coherence: Storylines, Phenomena, Essential Questions & Enduring Understandings

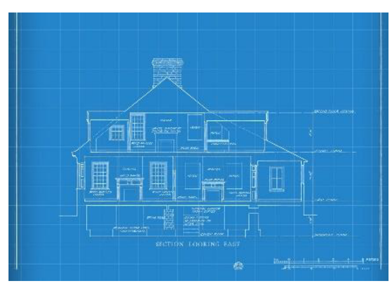
The goals for science education, as laid out in the NRC document *A Framework for K-5 Science Education*, include the following:

- Teaching science in a multidisciplinary fashion across the fields of science and engineering;
- Emphasizing both content and practices;
- Providing current and relevant examples and connection points for students; and
- Promoting a student-centric, inquiry-based approach to instruction that facilitates deeper understanding.

Achieving these overarching goals can feel daunting to educators. While the first place to look for help is the collective NGSS themselves, in the NRC's own words, *the NGSS are standards, not curriculum. [They] reflect what a student should know and be able to do—they do not dictate the manner or methods by which the standards are taught.*

To support teachers as they implement the NGSS a variety of best practices emerged. These include the use of storylines, phenomena, essential questions (overarching and topical) and enduring understandings. **At first glance these elements may seem self-explanatory, but as one digs into and starts to work with them, the *nuances* of their specific roles, and how the different concepts work together, can get a bit muddled up.**

So let's try to simplify the curricular elements using two analogies—building a house and Venn diagrams.

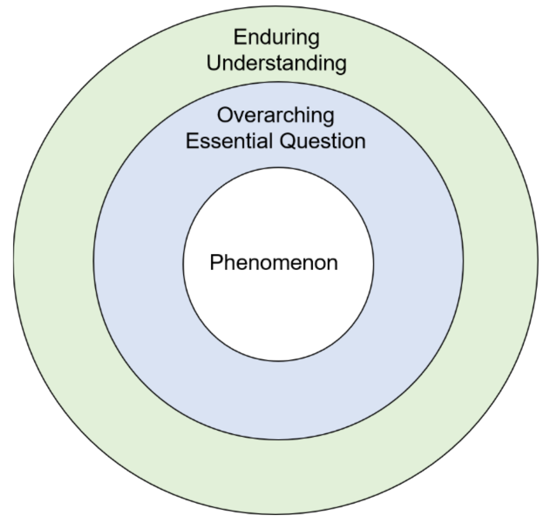


Building a House

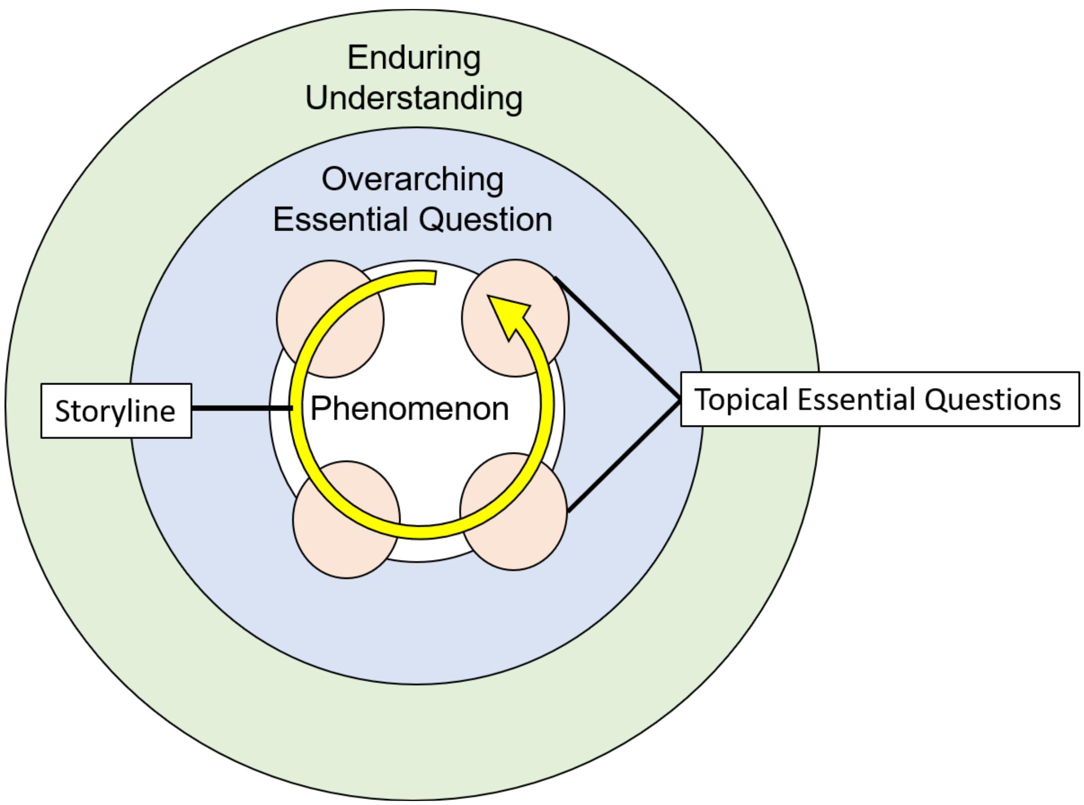
- The phenomenon is the house.
- The storyline is the blueprint.
- The overarching essential question is the style of the house (ranch, a walk-up, split-level, etc.).
- The topical essential questions are the style and contents of each room.
- The enduring understanding is the library of house styles to choose from coupled with the idea that the house style is ultimately determined by a combination of personal preference, budget, and geography (climate and resources).

Venn Diagram

Another way to think about this is as a series of concentric and overlapping circles—a Venn diagram of sorts. The phenomenon is at the center, completely encompassed by the overarching essential question. They are in turn encircled by the enduring understanding.



Layered on top of these three circles are the smaller, more specific, topical essential questions. The storyline becomes the path by which the topical essential questions are discussed.



The CreositySpace Approach

As you now know, all CreositySpace units start with a STEM entrepreneur, the businesses they are building, and the technology they are developing. This real-world example provides the basis for the unit's phenomenon, and the background motivation of the entrepreneur—typically a large-scale community need—provides the enduring understanding. Here is an example from our third-grade unit *Water Watchers*:

Phenomenon

How do we ensure everyone has the water they need?

Enduring Understandings

Water is critical to all living organisms. Different communities (humans, animals and plants) have different specific needs, face different challenges, and come up with different solutions to make sure they get the water they need. In this unit:

- Students will learn about the value of water, water quality, and water conservation.
- Students will develop an understanding water's role and importance to all living organisms.

Topical essential questions are associated with each investigation and used to help **provide the "why" around each concept or standard students are learning**. Also included are ***bigger wonderings*** (a.k.a. overarching essential questions) to **inspire deeper reflection and discussion**. Again, using the example from our third-grade unit *Water Watchers:*

Topical Essential Questions

- Where does our drinking water come from? How do we make sure we have clean drinking water? (3-PS2-1,3,4; 3-5-ETS1-1,2,3)
- How can we provide safe drinking water to rural and hard-to-reach communities. (3-ESS2-1,2)
- How do we get energy from water? (2-PS2-2)
- How do plants and animals get the water they need? (3-LS2-1, 3-LS4-4)

Big Wonderings/Overarching Essential Questions:

- How can we be more responsible in how we use and protect water?
- What do we need to do to best utilize and protect Earth's water resources?
- Given Earth's limited resources, how can we use technology to accomplish more with renewable sources of energy?

Finally, the **storyline** helps stitch things together so students can see the deeper connections between various investigations and incorporate that into their inquiry, discussion, and learning. An excerpt from the *Water Watchers* storyline is provided below.

> *In this unit students explore the importance of water in all Earth's systems. Connected by the overarching phenomenon of "How do we ensure everyone has the water they need?" students will explore sub-phenomena including "Where does our drinking water come from?", "How do plants and animals get the water they need?" and "How do we get energy from water?"*