Why Is Our Corn Changing?

[1.0 MI field trial version - fall 2016]

Synopsis: *In this second grade unit, students investigate the mystery of harvest corn, something they saw as decoration, beginning to sprout what look like leaves and roots. Disagreements about how the corn is growing spark investigations that lead students to uncovering the functions of different parts of the plant as well providing evidence for what plants need in order to grow.*

What students figure out *by the end of the storyline:*

- *Plants need light and water to grow.*
- *Plants have different parts that help them survive and grow*
  - *Roots help plants get water.*
  - *Leaves help plants get light.*
- *There is something inside a seed that needs water to start growing structures that will become the plant*
- *You can plan and design investigations to answer questions about what causes things to happen that you see going on in the world around you.*

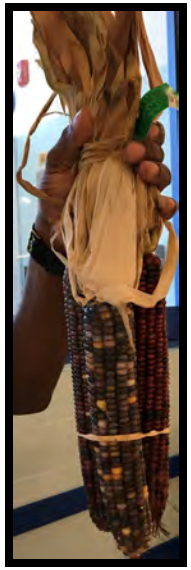
NGSS PERFORMANCE EXPECTATIONS BUNDLE

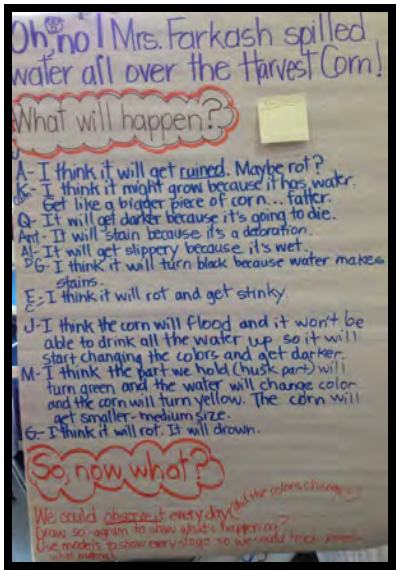
2. Interdependent Relationships in Ecosystems

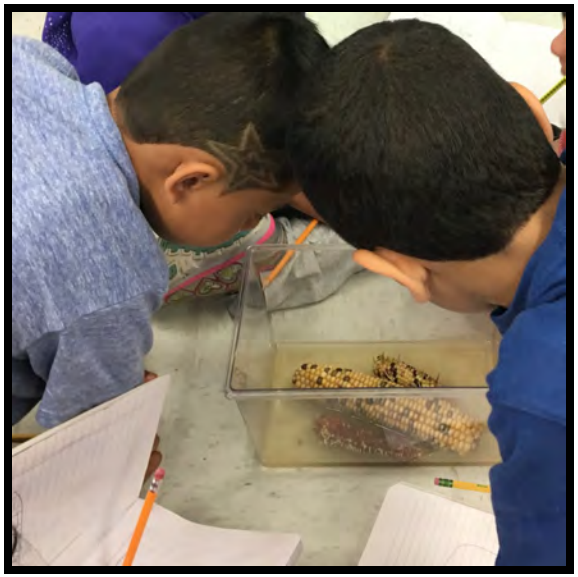
2-LS2-1	2-LS2-2	2-LS2-3

1. Structure & Function

1-LS1-1







These materials were developed through with support from grants from the Connecticut Department of Education; the Michigan Department of education, and he Gordon and Betty Moore Foundation to Northwestern University, and support from the NGSX Project at Clark University, Tidemark Institute, and Northwestern University.

Targeted NGSS Performance Expectation(s):		
• **2-LS2-1.** Plan and conduct an investigation to determine if plants need sunlight and water to grow.		
Targeted Scientific Practice(s)	**Targeted DCI(s)**	**Targeted Cross-Cutting Concept(s)**
Planning and carrying out investigations • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** • Plants depend on water and light to grow. (2-LS2-1) **LS1.A: Structure and Function** • All organisms have external parts...Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)	**Cause and Effect** • Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2) **Patterns** • Patterns in the natural and human designed world can be observed and used as evidence. (K-LS1-1)

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These materials were developed in part with support from an MSP grant from the Connecticut Department of Education, the Connecticut Science Center, the Michigan Department of Education; the Gordon and Betty Moore Foundation, and support from the NGSX Project at Clark University, Tidemark Institute, and Northwestern University.

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Development History:

- Design team starts work on Alpha version of storyline in the CT New Terrain project in Summer of 2014.
- Alpha version of storyline piloted by Lori Farkash, Nancy, Michael, and Ruth Purdie-Dyer in Fall of 2015.
- Design team expanded.
- Beta version of storyline developed in fall 2015 - spring 2016.
- Beta version of storyline piloted by Patty Whitehouse in Spring of 2016.
- Design team expanded
- 1.0 version of storyline and literacy supports developed in summer 2016
- 1.0 field trial PD in MI in fall of 2016.
- 1.0 field trials in MI in late fall of 2016.

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Key to storyline columns:

Lesson Question (time) *Building toward* ⬇ *NGSS PEs:*	**Phenomena**	**Lesson Performance Expectation(s):** • **Blue bold font: Science and Engineering Practice** • Regular font: Quoted from Appendix F Practices Matrix • *Italicized font: Specific storyline context (phenomena / question)* • Green font: Cross-cutting concept(s) • Orange font: Disciplinary Core Ideas (or pieces of these DCIs)	**What We Figure Out** (CCCs & DCIs), *New Questions* and **Next Steps** • Green font: Cross-cutting concept(s) • Orange font: Disciplinary Core Ideas (or pieces of these DCIs) • *Purple italicized font: New questions that we now have* • **Purple bold font: Our ideas for the next (or future) steps to pursue.**

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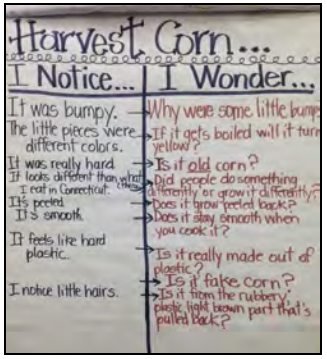
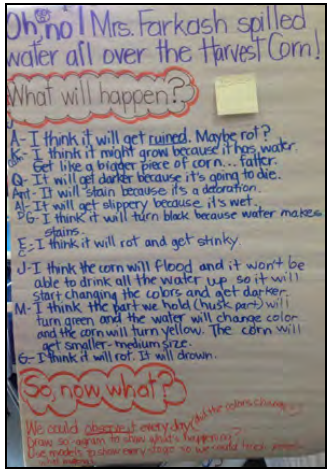
This Lesson....What we are doing now: This is the first lesson in the series. Students will make observations and ask questions about what they think will happen to a decorative piece of harvest corn accidently put in water. Encourage students to generate as many ideas as possible about what they notice and wonder.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L1: Is something going to happen to this harvest corn that got wet? (35 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Day 1: There is some harvest corn (multiple cobs) that were accidently left outside in a box and got wet.	**Analyze data** *(Noticing)* recording observations *of the **parts** (structures) and properties of these parts in the **harvest corn.*** **Ask questions** *(Wondering)* about *the **harvest corn parts** (structures), their properties, their function, and what patterns of **change** we might see in the wet harvest corn in the future.*	Our teacher explains something that happened to a decoration (harvest orn) he/she was going to bring to class. It got left outside in a box and got wet. Our teacher was worried it was ruined and asked us what we thought, "would anything happen to it?" We passed around some of the corn that was dried off, noticed and wondered and made some predictions about both the wet and dry corn. *We have questions about the harvest corn in the water:* • *Will the corn rot?* • *Will anything else happen?* *Others are questions about the dried off harvest corn:* • *Is it real or fake corn?* • *What is this thing?* • *Where did it come from?* • *What is it made of?* ***Next steps: We have ideas about what we want to investigate to help answer some of our questions:*** ***1. We can see if anything happens to this "harvest corn submerged in the water bin" each day.*** ***2. We can take some of the corn apart to see what it is made of, which might help us figure out if it's real corn (like we eat) or fake.***  

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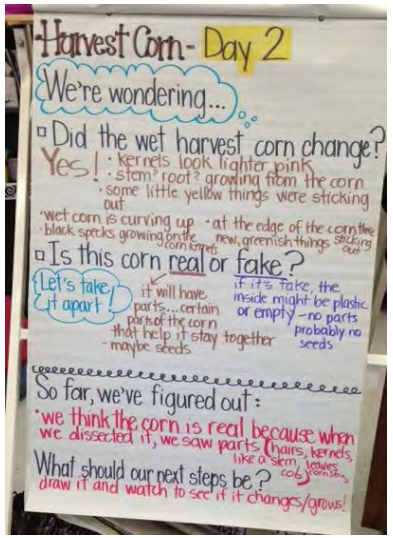
This Lesson....What we are doing now: Students will want to figure out what this stuff is made of. You will guide them to look at the structures of the corn more closely. Encourage students to take the kernels and the cob apart, and keep track of what they notice and wonder about.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L2: What is this thing made of? (55 min) *Building toward* ⬇ *NGSS PEs: 2-LS2-1*	 Day 2: Kernels can be separated from a cob in the dry harvest corn.	**Conduct an investigation** *(Investigate) dissecting the dry **harvest corn** to collect data about its **parts** (structures: kernels and a cob)* in order to answer a question and make comparisons *to the structures found in the corn we eat.*	We noticed that nothing much has happened to the harvest corn placed in water so far (pattern). We conducted an investigation of something we wanted to do last time, to take the corn apart to help us see if it is real corn. In doing so, we notice: • There are some interesting **outside parts** (kernels that come off), and there are additional parts/structures, like the cob. • These structures are similar to the corn we eat (patterns): both have a cob on the inside and a lot of kernels around the outside • The structures are different that the corn we eat (patterns): This stuff is much harder and not the same colors as the corn we eat. Because of some of these differences, we still aren't sure if this harvest corn is "real corn". However, we already know from 1st grade that **"all organisms have external parts"** (LS1.A, addressed in 1-LS1-1), and these external parts have some similarities so maybe it could be real corn. *We are wondering:* • *Why is it hard? Why is it shiny?* • *Is it living or nonliving?* ***Next steps: We still want to check in to see if anything happens to the harvest corn submerged in the water bin tomorrow and the next day and the next.*** 

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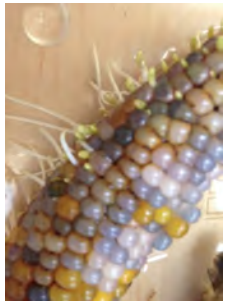
This Lesson....What we are doing now: Students will observe the corn submerged in water closely, paying attention to changes and patterns of change in the cob and kernels. They'll continue to monitor the changes in the corn as they collect more noticings and wonderings.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L3: What happened to the wet harvest corn? (50 min) *Building toward* ⬇ *NGSS PEs: 2-LS2-1*	 Days 3-5: The wet harvest corn has changed. There are things coming out of the corn.	**Analyze data** *(Noticing)* recording observations and describing patterns *in how the **wet harvest corn has changed**.* **Ask questions** *(Wondering)* about *what other patterns of change we might see in the future and/or might have caused these **changes**.*	Getting the harvest corn wet seems to have caused changes in it. We notice patterns and changes: • Little things are coming out of the corn • The kernels are becoming more plump and large • The corn is surrounded by water and is near the window. *We are wondering:* • *What are the white things? Are they roots?* • *Did the water help it? Will anything happen without water?* • *Is it because it was next to the window? Will this happen in the dark?* • *Why are the pieces of corn getting bigger? Are those kernels seeds? Is this a plant?* **Next Steps:** **1) We want to figure out what the little things coming out of the corn are.** **2) We want to see if anything new happens to this harvest corn submerged in the water bin each day.**

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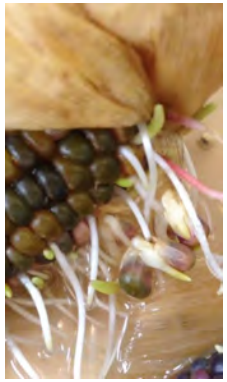
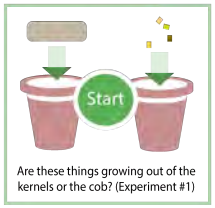
This Lesson....What we are doing now: Students will need to figure out that the little things look like they are getting longer and bigger, and that its hard to tell whether they are growing from the cob or the kernels. This will motivate the 1st experiment you will guide the class to want to set up at the end of this lesson.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L4a: Now what happened to the wet harvest corn? (60 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Day 6: More stuff is coming out, and the stuff is longer and some kernels have fallen off.	**Analyze data** *(Noticing)* recording observations and describing patterns *in how the wet harvest corn has changed.* **Ask questions** *(Wondering)* about *what other patterns of change we might see in the future and/or might have caused these* ***changes****.* **Design & conduct an investigation** with peers (and teacher guidance), to determine, *which structure are these things coming out of, the kernels or the cob?*	We notice patterns as the wet harvest corn changes: • More stuff is growing out of the corn. • White (and other colored - some green) things look like they are getting longer/bigger. • We notice that the water level is going down. • Some kernels look like they are being pushed off the cob or the cob is falling apart. We argue from evidence that: • We know from 1st grade that "**plants...have different parts that help them...grow**" **(LS1.A)** so we are thinking that these green and white things are growing since they seem to be getting longer. • If water level is going down, the water must be going somewhere (matter flows). We think maybe the water is going into the corn. We do not all agree on which part of this thing stuff is growing from. Some think the parts are growing from the kernels, and others think they are growing from inside the cob. *Now we are wondering:* • *Is the water going up into the plant? Or is it disappearing?* • *Are the little things growing from the corn or the cob?* ***We want to design an investigation to figure out whether these little things are growing from the kernel(s) or the cob. We know from our dissection of the dry harvest corn that there is a cob on the inside and kernels are stuck to it.***  Are these things growing out of the kernels or the cob? (Experiment #1) So we plant the kernels and the cobs separately (or put these in water) to see which, if either, will grow. This is Experiment #1. Since we need to wait a few days before we can see what happens in this experiment, we make a record of this investigation plan (our noticing, our question, our procedure, our prediction) and we move on to planning how to investigate our other question(s) for now. ***Next steps: We will look at the results of this experiment in L4(b). We also want to see what happens with the wet corn next time, so we add more water and measure the amount of water we add every time.***

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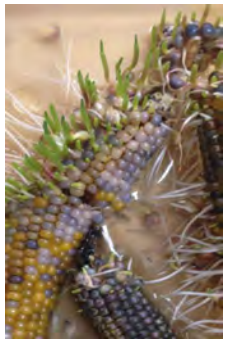
This Lesson....What we are doing now: While your students are waiting for the experiment with the kernels and the cob to grow, they decide to check back on the original harvest corn submerged in water. Encourage students to think about, "how do we really know if something is getting longer or not?"

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L5: How much did the wet harvest corn change? (40 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Days 7-9: The green and white things are growing longer.	**Analyze data** *(Noticing)* recording observations and describing patterns *in how the wet harvest corn has changed.* **Ask questions** *(Wondering)* about *what other patterns of change we might see in the future and/or might have caused these* ***changes****.*	We notice patterns as the wet harvest corn **changes**: • The white and green parts look like they are getting longer. • The water went down, so we added more water. We wanted to say argue that is evidence that the harvest corn was growing, but then realized that we didn't have evidence for growth, because it is hard to know for sure if it is growing bigger unless we have a record of how big it was the day before. If we did have those measurements, then we could tell it got bigger by a comparing the two measurements. *Now we are wondering:* • *Are the parts really getting bigger? How much bigger?* • *If its parts are getting bigger, does that mean its living?* **Next steps: In order to keep track of this we decide we should start measuring each of these structure coming out of the harvest corn with a ruler (to the nearest half centimeters) and keep track of this in our notebooks. We want to keep track of the water we are adding too, since maybe that is related to what we see the harvest corn doing.**

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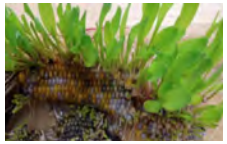
Why Is Our Corn Changing?

[1.0 field trial version - fall 2016]

This Lesson….What we are doing now: When presented with a new phenomena, the video clip of plants growing toward light, students will wonder whether light has anything to do with the growth they've noticed on the corn. They'll design an investigation to test whether or not light is needed.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & **DCIs**), *New Questions* and ***Next Steps***
L6(a): Why are the different parts growing in different directions? (75 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Day 10: Green sprouts are now widening at the top. A timelapse video of tomatoes plants show the green parts of them bending toward the light and growing in that direction over time:	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths,, describe (and graph) patterns in *how the* ***much the wet harvest corn grew and what else has changed.*** **Ask questions** *(Wondering)* about *what other patterns of change we might see in the future and/or might have caused these* ***changes****.* **Design & conduct an investigation** with peers (and teacher guidance), to determine, *if our harvest corn needs light to keep growing?*	We notice patterns as in how the wet harvest corn changes : • We have measurements that help us prove the green things are getting growing we calculate the difference between our measurements as evidence of how much it grew). • We have similar calculations, that provide evidence that the white things are growing longer too. • The green parts kind of look like leaves. They are bending toward the light. • The white parts kind of look like roots. They are bending toward the water. We argue from evidence that this thing is growing (its structures are getting longer) and it's starting to look more like a plant. *Now we are wondering:* • *So are the green things related to something about light? Are they leaves or not?* • *So are the white things related to something about water? Are they roots or not?* We decided to see if something we know is a plant bends its leaves toward the light as it grows. So we looked at video recording of a tomato plant growing over many days (a time-lapse - fast forward video). We noticed similar patterns in how the tomato plant in the video grows and changes. Its leaves are growing toward the light. We argue from evidence that because the our thing is growing toward the light, just like the tomato plant is: • It might be a plant; these green things might be its leaves • Maybe the leaves are for helping the plant get light • Maybe all plants might need light to grow. *Now we are wondering: Does this thing need light in order to keep growing?* **We decide to break off a chunk of cob and put it in the dark and keep in the light. We don't want to put all the corn in the dark because then we couldn't tell if the dark makes a difference without anything to compare it to. This is Experiment #2.**  Does it need light to keep growing? (Experiment #2) Since we need to wait a few days before we can see what happens in this experiment,we make a record of this investigation plan (our noticing, our question, our procedure, our prediction) and we move on to planning how to investigate our other question(s) for now. ***Next steps: We will look at the results of this experiment in L6(b). We also want to see what happens with the wet corn next time, so we add more water and measure the amount of water we add every time.***

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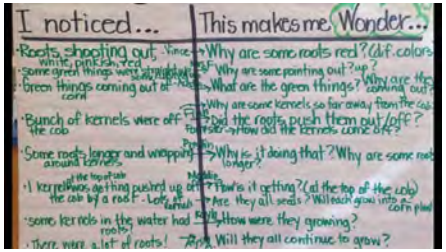
This Lesson....What we are doing now: You will help students take stock of all the interesting noticings that have observed so far, the claims they can make based on the evidence they have so far to conclude that the harvest corn is a living plant, and the questions that have yet to answer. (If the class has done Notice and Wonder most days and decided that the corn is a living plant, this lesson can be omitted).

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & **DCIs**), *New Questions* and ***Next Steps***
L7: What have we noticed and what are we wondering so far? (50 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Day 11: Roots are more intricate. Leaves are getting darker greener, bigger, opening up/uncurling. Very little of the seed is left. Kernels are falling apart. The roots are still white.	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths, and, describe (and graph) patterns in how the much the wet harvest corn grew and what else has changed. **Ask questions** *(Wondering)* about *what other patterns of change we might see in the future and/or might have caused these* ***changes****.* **Engage in argument from evidence** to answer the question whether this thing ***is a living plant(s)?, by*** *analyzing why these different forms of evidence: patterns of growth, similar structures, and predictable stages of development are relevant to the question.*	***We decide to check up on our noticings and wonderings.*** (If the class has done Notice and Wonder every day and decided that the corn is a living plant, this lesson can be omitted. If the class has not had a chance to do a notice and wonder day in a while this is a time to take stock of what the students have figured out so far, and what we still have questions about.)  *Example observations and questions:* • *We keep having to add water to the harvest corn every day. Maybe the cob is using up the water?* • *The white things look like roots and they are growing toward the water. So are the roots related to something about water?* • *Do the different parts do different things? We think maybe...* • *Will the roots keep growing? How tall will the green things get?* • *Is it one plant, or many plants?* We argue from evidence to answer an earlier question: *Is this thing a plant?* • We from our measurements that a lot of growth and change is taking place. Since "plants...grow and change" (LS1.B, addressed in K-LS1-1), we think this is evidence that this may be one or many plants. • It has green parts as well as the shape of parts (structures) that plants have like roots, stems, and leaves, and it doesn't move around, which we know from personal experience. We already know that "Plants...have different parts (roots, stems, leaves…)" (LS1.A, addressed in 1-LS1-1). And with it growing, this makes us really certain this is a plant. • We also see that we can break off different parts of the cob and grow them separately. And the different corn plants all look different from when they were younger, which means that they must grow in a similar way. ("Plants...have predictable characteristics at different stages of development." (LS1.B)) So now we think this may actually be many plants growing at once. ***Next steps: We also want to see what happens with the wet corn next time, so we add more water and measure the amount of water we add every time.***

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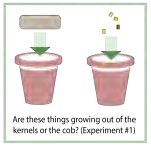
This Lesson....What we are doing now: It's time to check on the results from Experiment 1 in lesson L4(a). You'll guide them to analyze the two different containers, one with the kernels planted and the other with part of the cob planted through the cross-cutting concept lens of structure and function.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L4b: What did we figure out by planting the kernels and the cob?  (70 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Day 12: When we check back at our Experiment #1 the corn cob alone didn't sprout, but the kernels did (5-6 days after planting)	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths, and, describe (and graph) patterns in how the much the wet harvest corn grew and what else has changed. **Engage in argument from evidence** by co-constructing a oral & written argument supported by evidence that a different plant is growing from (a particular structure) each kernel, not from the cob.	We notice patterns in how the wet harvest corn changes : • The corn cob didn't sprout, but the kernels did. • Each kernel is sprouting its own plant structures. We argue from evidence: • The kernel is the part (structure) that the plant grows from, not the cob. • Other plants we know grow from seeds (**"Plants also have different parts...that help them...produce more plants" (LS1.A).**, so since the kernel is growing a new plant, then it must be a seed, not the cob. • The purpose (function) of each kernel/seed - is to help the corn produce another plant. The seed of the plant is a key structure that helps the plant produce another plant • There are many kernels on the cob, and each of the kernels are sprouting. Therefore the corn has many plants growing from it, because it has many seeds on it. Each kernel can grow into a separate corn plant. *We have a new question that came from these results: What's inside that seed that helps the plant grow?* **Next steps: We want to look inside seed) to see if there is anything inside of it that is responsible for this growth we are seeing coming from it. We think we can look at a seed of any plant to figure this out, because seeds are the structures that produce new plants.**

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This Lesson....What we are doing now: Students will watch a time-lapse video of a bean sprouting, which will lead them to investigating what is inside a bean through dissection. Through their investigation they will figure out that all wet seeds have tiny plant structures (roots) in them that will help the plant grow.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L4c: Does the seed have something inside of it that is helping the plant grow? (75 min) *Building toward* ⬇ *NGSS PEs: 2-LS2-1*	Day 13: A timelapse video shows structures (similar to those we saw on harvest corn) sprouting out of a bean in wet dirt. Dissection of a wet seed sitting in water for a day reveals different structures inside of it then a dry seed that was not sitting in water. 	**Conduct an investigation** *(Investigate)* dissecting a dry and wet lima bean to *determine the **parts** (structures) inside the wet lima bean that helps it produce a baby plant.* **Engage in argument from evidence** to answer the question, "Does the seed have something inside of it that is helping the plant grow?" making a claim that the **wet seed** has **some** root-like structure **growing in it** but the dry seed does not.	**We were wondering if the seed has something inside of it that is helping the plant grow, we thought we could look at a seed from another plant to figure this out, because seeds are the structures that produce new plants, but wanted to confirm this, so we wanted to see a different plant growing from a seed.** From observations made from the time-lapse video, we notice patterns: • Plant structures are sprouting out of a wet bean (seed). **Now we think we could dissect a bean seed instead of corn, to see what, if anything, is inside the seed, that is helping the plant grow, since beans are bigger and easier to cut and corn is small and hard to cut.** From the dissection we notice patterns: • Most wet seeds have a small root inside them, but dry seeds don't. • There isn't a baby plant inside the seed, but there is a structure there (similar to the roots we've seen that plants have that looks like what sprouted out of our harvest corn and grew). **Some of us can't believe what we see and want to check whether this is also in other seeds.** From repeated observations we notice: • There is one of these structures in each seed that we look at. We argue that the wet seed has a root like structure growing inside of it that can produce a baby plant, but the dry seed does not So.the function of the seed is to help produce more plants from growing a small root in them. Seeds must get water from its surroundings from this root structure, which allows it to start growing a baby plant inside them because there was no other visible plant structures inside the dry seed. The water must cause the seed (kernel) to start growing this root-like structure. So from this argument we now think that: • **"Plants also have different parts...that help them...produce more plants" (LS1.A)** • **"Organisms [plants] obtain the materials they need to grow...from the environment" (LS2.B)** because the only difference between the dry and wet seed, was that they soaked in water. If students ask for multiple beans to dissection, then: We also argue that we wanted/needed to look in more than one seed, because what we were seeing didn't match what we expected (it was kind of unbelievable). We decided that this gives us an

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			idea of what is a good thing to do in any investigation: when we see something that doesn't match what we expect, it is becomes more believable if we repeat it and get the same result. **This is something we decided to keep in mind for future investigations we design.** ***Next steps: We also want to see what happens with the wet corn next time, so we add more water and measure the amount of water we add every time.***

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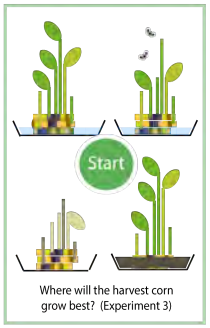
This Lesson....What we are doing now: Many classes will notice that the leaves of the harvest corn appear to be bending toward the window near where they are growing. When presented with an additional phenomena, the video clip of plants growing toward light, students will wonder whether light has anything to do with the growth they've noticed on the corn. They'll design an investigation to test whether or not light is needed.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L8(a): How did the harvest corn change? (55 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Day 14: The water is getting stinky and gray and cloudy and fruit flies are flying around these plants	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths, and, describe (and graph) patterns in how the much the wet harvest corn grew and what else has changed. **Ask questions** *(Wondering)* about *what other patterns of change we might see in the future and/or might have caused these* ***changes****.* **Design & conduct an investigation** with peers (and teacher guidance), to determine, *where will our harvest corn grow best (in clean vs. dirty water or in dirt vs. no dirt)?*	We notice new patterns in how the wet harvest corn changes : • The water that our corn cob is sitting in is getting stinky • The water is cloudy and gray • Fruit flies are flying around the plants We argue that that the dirty water is an example of when **"the places where plants...live often change, sometimes slowly and sometimes rapidly." (LS2.C)** *This stinky water has raised new wonderings:* • *Will those roots keep growing?* • *Will the leaves keep growing?* • *Will it die in this water? Is something wrong?*  Where will the harvest corn grow best? (Experiment 3) Some of us think the plant might die if we keep it in the stinky water. We decided something might be wrong in the water, but we aren't sure, so we want to do an experiment/design a solution to see if the cloudy water is affecting its growth. This led us to wonder if other types of water or dirtiness affect the growth of our plants. This leads to a broader question we want to investigate*: Where will our harvest corn grow best?* **We set up four different conditions for our plants (old water, fresh water, soil with water, and no water). We measure their current size/height and take observations to see if there will be a difference in these different environments. This is Experiment #3.** Since we need to wait a few days before we can see what happens in this experiment, we make a record of this investigation plan (our noticing, our question, our procedure, our prediction) and we move on to planning how to investigate our other question(s) for now. ***Next steps: We will look at the results of this experiment in L8(b). We also want to see what happens with the wet corn next time, so we add more water and measure the amount of water we add every time.***

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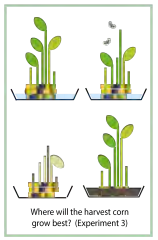
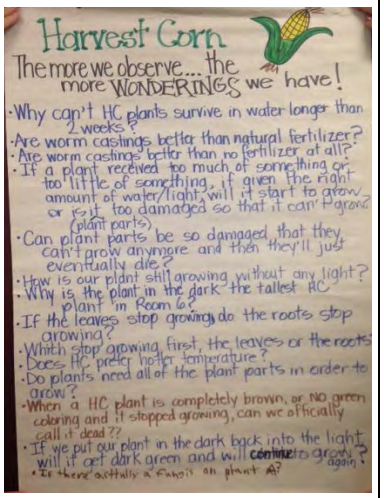
This Lesson....What we are doing now: Today students will go back to observe experiment 3. They will analyze the results of the experiment by comparing plant growth across the four conditions (clean water, stinky water, no water, soil and water). Students will conclude that the plant growing in soil and water is the healthiest, while the one without water is dying. They will conclude that plants need water to grow!

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L8(b): What did we figure out by putting it in different places?  *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	 Days 15-20: Different amounts of plant growth and change under different conditions. Plant in nothing dies. Plant in soil with water grows the highest and has the least discoloration. The plants in the freshwater grow almost as well as those in soil. And plants in the stinky water grow the least.	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths, and, describe (and graph) patterns *in how the harvest corn* ***grew and what else has changed.*** **Engage in argument from evidence** by co-constructing a oral & written argument supported by evidence *that* ***plants need water to grow, but they don't necessarily need soil.***	We see a pattern that the different plants grew to different heights. But analyzing the data was particularly tricky because more than one thing was changed in some of the containers we compared to one another.  We decided we needed to compare containers where only one thing was different between how they were setup in order to know for certain that the the difference in results was due to one of those things. We decided to refer to this kind of comparison as a fair test. When we compare patterns across fair tests, we see that: • Plants grow better in clean water than dirty water • Plants grow more upright in dirt and water than in dirt alone • Plants don't grow when they have no water, even if they are in dirt. We argued from evidence that: • Plants must need their roots to be in water to grow, and can only grow in places with water that their roots can reach. This makes sense, as we noticed earlier that the water level was going down. We can think of other examples of things not growing if they don't get what they need, too. For example, a household plant dying because it wasn't watered. • Plants grow more upright when their roots are in soil, but don't need soil to keep growing. From this we can conclude a cause and effect relationship.**"Plants depend on...water...to grow" (LS2.A)."** Similarly, **"Living things can survive only where their needs are met" (LS4.C).** *We think we can get more evidence from our remaining experiment (#2) and from any new experiments that we want to design in order to help us figure out else plants need to grow and what else in the environment affects their growth.* ***Next steps: So we still need to look at the results of experiment 2 in L6(b).***

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This Lesson....What we are doing now: Today we return to the two corn plants we planted in Lesson 6(a) (Experiment #2) to collect data that will help us make claims about whether or not our corn needs light to grow.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L6(b): What did we figure out by putting it in the dark and in the light?  Does it need light to keep growing? (Experiment #2) (60 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	Day 18 (or later): Results from Experiment 2: The corn cob grown in the light vs. dark has different patterns in terms of the color of leaves, number of sprouts and change in the length of sprouts.	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths, describe (and graph) patterns in *how the* ***much the wet harvest corn grew and what else has changed.*** **Engage in argument from evidence** by co-constructing an oral & written argument supported by *patterns in the data (evidence) that* ***plants depend on light to grow.***	From Experiment #2, we notice various patterns: • The green shoots/leaves of the plant in the dark are shriveling and turning yellow and brown, but the plant in the light is not. • The plant in the light has more sprouts than the plant in the dark. • The length of the green sprouts in the light and the dark and the ones in the light are much longer than the ones in the dark. We argue that **"Plants depend on...light...to grow" (LS2.A)** because of the patterns we noticed from our experiment. We decide on cause and effect and structure/function relationships: • Since the roots go toward water and the leaves head toward light, we think the plant gets water from its surrounding through it roots and it gets light from its surroundings from its leaves. This is additional evidence that **"Plants also have different parts...that help them survive, grow..." (LS1.A).a** *One new question that came up was: We think that light is important for plants to grow, but do they need it as a seed too?* **Next steps: Though we are pretty sure that the plant needs water and light to grow, we now have some other ideas of experiments we could do to test this. We also have ideas for testing whether there are other things the plant might (or might not need) to grow. We want to start our own experiments next.**

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This Lesson....What we are doing now: Even though we've figured out several things about plants, we now have individual questions that we would like to explore. For example, we think that leaves might help gather sunlight, but could a plant still grow if all the leaves were cut off? Let's plan an experiment!!

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L9(a): What else do plants need to grow? (120 min) Recommended over 2 days, 60 min each *Building toward* ↓ *NGSS PEs:* *2-LS2-1*	Day 21: Materials to design experiments, including already sprouted beans or corn, various seeds etc.	**Design & conduct an investigation** with peers (and teacher guidance if needed), to determine an answer to a question about what else (other causes) do plants need to **grow** (effect)**?**	**Experiment #4: We get ready to plan our experiments to answer some of our own questions.** **We review the questions from all of notice and wondering charts, and pick some of these them from a gallery walk as candidates we might be interested in investigating further.** **As a group we decide *on our question*, materials and tools, and procedure in our investigation plan. We also decide what data we want to keep track of. For example, some students may need to measure the green sprout growth or root growth, others might need to measure how much water they are adding every day and what color light their plant is growing in or count how many plants turn brown.**  My own groups' question. (Experiment 4)

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This Lesson....What we are doing now: Students will carry out their independent research experiments. They will be collecting data they decided was relevant to their research question and begin to analyze their data for patterns. They may need support from you to problem solve roadblocks that arise.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L9(b): How much did my plants grow?  My own groups' question. (Experiment 4) (45 min) +15 min every other day for 10 to 12 days *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	Day 22-31: Observations from our own experiments.	**Analyze data** *(Noticing)* **and use mathematical thinking** to record observations, measure lengths, and, describe (and graph) patterns *in how the much each of the plants in the group's different conditions* ***grew and changed.***	**We carry out our investigations and are continually collecting data over the next 9-10 days.**

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This Lesson….What we are doing now: Today we wrap up our investigations by collecting and analyzing our data. We will use this data as evidence to explain what we learned about the structures of the corn plants and the functions of each of those structures. And we start writing up our results to share with our classmates.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L9(c): What did our group figure out from our investigation?  (120 min) Recommended over 2 days, 60 min each *Building toward* *NGSS PEs: 2-LS2-1*	Day 32-34: The results of our experiment and our own group's claim(s).	**Engage in argument from evidence** by constructing a written argument supported by patterns *in the group's data (evidence) that answers the group's question about what else (other causes) do plants need to* ***grow*** *(effect)****?***	Now that we have our results, we are so excited about our results! We want to share what we learned with others, and want to hear what they figured out too. *This raises a new question: How can we communicate what we learned?* We agree that others will want to know more than just our discoveries, they will want to know how we figured it out, and the question that motivated the investigation. We decide that writing up our findings using what we learned about how to write an investigation plan and an evidence-based claim in earlier investigations would be a good approach. We decided to refer to these two things as our "Discoveries Report" We refer to our worked examples from Lesson 4a, 4b, 6a, 6b, 8a, and 8b, that are posted in the room to outline our own writing and model for what we want to share with other classmates what we did and what we learned from it, and to hear what they did and learn from them. ***Next steps: We want some time to finish constructing our discoveries report. And then we want time to to share these with our classmates and others who might be interested.*** *Maybe some of our parents or other teachers might want to drop in to hear about what we figured out?*

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This Lesson….What we are doing now: Today we will share our findings with our classmates, using our Discovery Report as a guide. We will summarize all of the cause and effect relationships we learn about as our classmates share the results of their investigations.

Lesson Question	Phenomena *Days of plant growth*	Lesson Performance Expectation(s)	What We Figure Out (CCCs & DCIs), *New Questions* and ***Next Steps***
L9(d): What has our class figured out from all of our investigation? (60 min) *Building toward* ⬇ *NGSS PEs:* *2-LS2-1*	Day 35-36: The results of all of our groups' different experiments.	**Communicate information** with others *(classmates and guests)* presenting in oral and written forms using models, drawings, and writing, about *our research question, our investigation plan, the patterns in our data we collected, and the claims we can make based on this evidence about what else (other causes) plants need to* ***grow*** *based on that evidence.* **Engage in argument from evidence** by listening actively to arguments to indicate agreement or disagreement based on evidence, and/or to retell *the claim about plant growth that each group is making and the patterns in their data (evidence) that supports their claim.*	We shared our findings and heard from other groups. We restated what their discoveries were and the how the evidence they collected supported their claims. Our teacher kept track of these discoveries of the whole class, summarizing in a cause and effect relationships like: • Plants grow better with sunlight. • Plants grow with other types of light. • Plants need light to keep growing. • Plants need water to keep growing. • Seeds need water to start growing. • The environment that the plants grow in is important. • Soil might be important to helping plants grow. • Every time we start a new experiment we see the same patterns happening, even if we all planted different types of plants. Little white things shoot up out of the seed, some white things shoot down. The white things that were up, start to turn green and become wide, flat, and tall. They also will bend towards the light. Plants look different from when they were younger, which means that they must grow in a similar way. **("Plants...have predictable characteristics at different stages of development." (LS1.B))**

Wow, we figured out so much! Light and water and lots of things in the surroundings around the plant affect how and whether it grows. This got us wondering…. Would this be true outside too? Do differences in the surroundings affect how plants grow or what plants grow there? Do all plants need the same amount of light and water to grow… We just got a lot more ideas for morer investigations….

Check back for the sequel to this storyline: "(Why) Are There DIfferent Plants Growing In Different Places?"

- **5 more performance expectations, all that leverage what we figured out in this storyline**
- **Alpha pilot ongoing in fall 2016. Beta pilots targeted for early spring 2017.**

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