Creating Culturally Relevant Science Stories

Connecting Students' Lives to Pedagogy

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Multidisciplinary learning is a key focus of 21st-century learning (Barbara 2016), the *Next Generation Science Standards* (*NGSS*), and the *Common Core State Standards*. In addition, the *NGSS* emphasizes providing equitable learning opportunities by integrating students' linguistic and cultural resources into science education (Lee 2005), thus creating a connection between students' primary language and scientific language. With this research in mind, we developed a weeklong informal learning program for immigrant students, which was sponsored by our State Department of Education (SDOE) Migrant Program.

Twenty-five sixth- to eighth-grade students (18 females and seven males, ages 10 to 14 years old) participated in the program, all of whom were selected based on the SDOE's criteria of interrupted education. In addition, all of the participants were children of migrant farmworkers from Mexico and spoke Spanish at home. Many lacked grade-level academic proficiency in English, and one student was a beginning English-language learner. Inspired by culturally responsive pedagogical approaches (Atwater 2010), we wanted to make a direct connection to our students' lives (González, Moll, and Amanti 2005). Because our students' parents were all farmworkers, we focused our curriculum on soil ecosystems. (*Safety note*: Please make sure to follow safety precautions listed in activity descriptions in Resources).

Starting with a relevant story

We began our instruction by reading aloud *Radio Man* (Dorros 1997), a story describing a migrant boy named Diego who travels the United States with his family to harvest crops. This book is relevant to students' cultural and experiential backgrounds. Using picture books in middle schools is a great strategy because of their appeal to students, which enables teachers to address a concept through a short and engaging story (Alvermann 2002). According to Stevenson and Beck (2017), picture books have been proven to be excellent mentor texts for students' writing. In addition, including culturally relevant instructional materials, such as *Radio Man*, serves to "validate the students' ethnic and sociocultural experiences" (Stevenson and Beck

CONTENT AREA

Earth and life science

GRADE LEVEL

6–8

BIG IDEA/UNIT

Soil ecology

ESSENTIAL PRE-EXISTING KNOWLEDGE

ecosystem, abiotic and biotic factors, nitrogen cycle, plant growth and development, how soil is developed

TIME REQUIRED

One week (five days, four-hour class sessions)

COST

Chemical testing kits, which can be purchased from various vendors for $20 to $50.

SAFETY

See Resources for specific safety notes for each activity.

2017). In fact, when we asked how the story compared and contrasted to their own lives, our students shared how they could relate to Diego's experience because their families also traveled to find work harvesting fruits and vegetables.

To begin integrating soil ecosystems into the lesson, we discussed how the book highlighted different fruits and vegetables that Diego and his family harvested across the United States. This led to a discussion about the necessary growing conditions for the different plants. We asked students guiding questions such as, "In your experience, what do plants need to grow? How important is soil to a plant's growth? Based on your own experience, where do the best crops grow?" These questions prompted several students to share information about the various crops their families had grown and harvested.

Students next worked in pairs analyzing a Google map we made based on Diego's travels in the story (see Resources). Students were assigned a partner for the week, based on the students' ages and grade levels. Student pairs analyzed topographical features, fresh water availability, soil profiles, and climate patterns for each of the locations using the SoilWeb interactive Google map, which provides a tutorial on how to access these map layers (see Resources). Students also used the Google map to solve math problems we created based on Diego's travels (see Resources for Google map and math problems).

Creating stories with RAFT

Over the course of the week, partners worked together to write a digital children's book describing the perfect place to plant a seed. To aid in the development of their story, we provided the students with a RAFT technique (Role, Audience, Format, Topic), which is a writing strategy that helps students write a topic from different perspectives, understand their role as writers, use different formats, and identify their audience (Santa, Havens, and Valdes 2004; see Figure 1). We gave each pair freedom to choose a favorite vegetable or fruit for their story, and we also gave additional student choice by providing two options for the role and the audience.

FIGURE 1: RAFT—Role/Audience/Format/Topic

Writing a creative academic narrative/story

Start

Choose your favorite vegetable or fruit

Option 1

Role:

Pretend that you are a seed of your favorite vegetable or fruit. Pretend you have a furry animal friend (squirrel, opossum, rabbit—any animal you choose) who is willing to help you search and find the perfect new home for you to grow into a healthy plant.

Audience:

Tell your furry friend where you need to go. Tell him or her what to look for and what to avoid as he or she helps you to find your new home.

Option 2

Role:

Pretend that you are a mature plant of your favorite vegetable or fruit. Pretend that your children (your seeds) are all about to leave home to seek new places to settle down and grow.

Audience:

Tell your seeds where they need to go. Give them advice about what they should look for and what they should avoid as they travel to find their new places.

Format:

First person (using "I") creative academic story for a children's book (ages 4 to 6)

Topic:

Finding the perfect place to grow

Regardless of the role you choose, use what you are learning in class to explain what conditions are necessary/ideal for your favorite fruit or vegetable to grow.

Examining soil

The story topic, finding the perfect place to grow, was used to determine the science investigations and instruction students participated in throughout the week. For instance, on the first day, students explored and examined various local soil samples we collected from around campus. Each pair was given their own soil sample. Ideally, students would collect their own soil sample; however, previously collected soil samples could be used depending on the weather. To collect the samples, students can use a small trowel to remove a small section of soil, place the sample in a resealable plastic bag, and then take it back to the classroom. Prior to the activity, teachers should inspect the schoolyard for any holes or obstacles that may cause trip-fall hazards. Teachers should also receive permission from the building administration before collecting soil samples from schoolyards. At the conclusion of the day's activity, we asked students to record in their science journal responses to the following guided questions:

- What is an ecosystem?
- What are the biotic and abiotic components?
- How are ecosystems organized?
- What did you learn today?

During the soil examination, students were encouraged to touch and smell the soil by wafting (cup hand over soil, moving air toward you to smell), and they recorded their descriptions in a data table contained in their science journals (see Resources). Students were curious about the texture of the soil when it was wet, which led to a student-driven examination of wet versus dry soil. As students observed the soil, they noticed organisms (e.g., earthworms, pill bugs, nematodes) moving in their samples.

Students used hand lenses and microscopes to examine the organisms, and they excitedly shared their findings with other groups. Students were able to identify the organisms, except for nematodes, using their prior knowledge. (We helped students identify the nematodes.) At this point we placed a small amount of soil in a beaker with distilled water to examine microorganisms (e.g., tardigrades, rotifers) on the following day. Students explored, observed, and recorded their observations for two hours and did not want to leave the lab when it was time to leave for the day. Students recorded in their science journal observations such as the smell of soil, feel of soil when dry versus wet, and types and number of organisms found in the soil. At the end of the activity, students answer the following questions in their science journals:

- What did I observe during my science lab?
- How can I connect my observations from today's readings, lesson, and lab, with my own experiences?

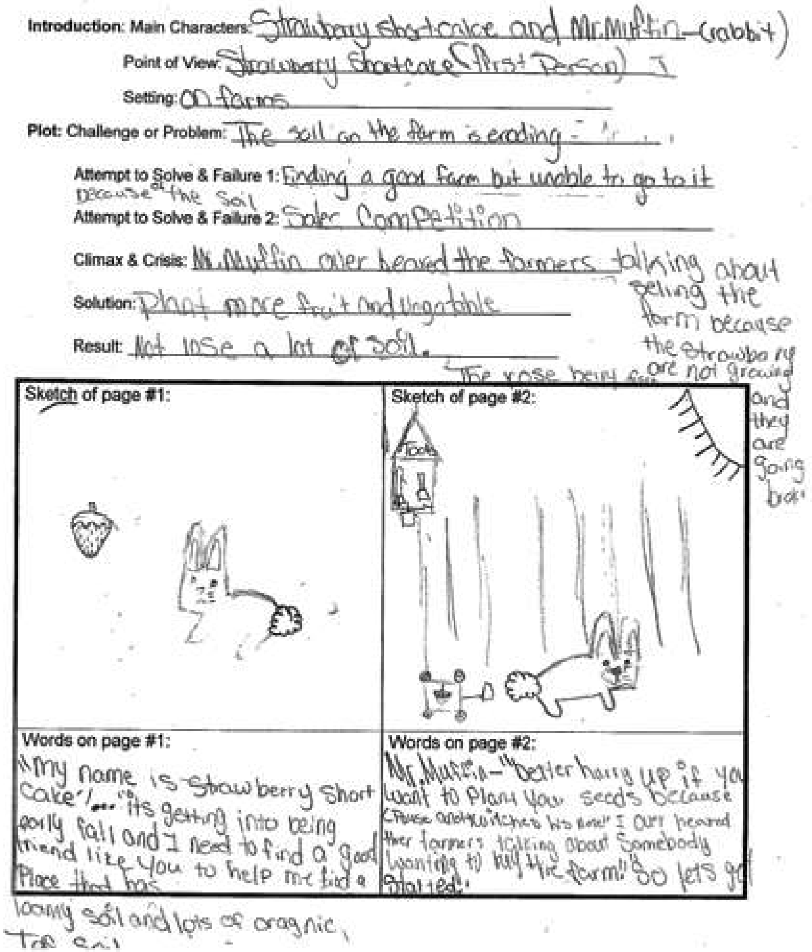
Framed paragraph and research skills

On the second day of our program, students conducted qualitative and quantitative analyses to determine the texture of their soil sample. First, students explored the textures of sand, silt, and clay samples (purchased from a local hardware store) that were dry and wet. This knowledge helped them conduct the qualitative "ribbon method" investigation (see Resources), which determines soil texture by rubbing soil in the palm of one's hand and observing its shape and length. Subsequently, an interactive lecture was given to explain even more about soil textures through questions and photograph analysis. During the interactive lecture, students responded to questions by writing in their science notebooks and discussing their responses to the class. Students were encouraged to draw examples similar to the photographs analyzed to help them remember academic vocabulary from the lesson. To elaborate further, students set up a mechanical analysis, a quantitative method for determining soil texture, during which the soil sample settles into layers overnight (see Resources). On the following day, students calculate the percentage of each layer.

After finishing their experiments, students completed a framed paragraph activity (see Online Supplemental Materials). Framed paragraphs or paragraph frames with sentence stems and fill-in-the-blank spaces serve as scaffolds for students working on a new genre in academic writing, and they especially assist English language learners or students who struggle with organization and structure in writing. We also discussed with students how the use of vocabulary words and data in the framed paragraph was a resource for constructing their children's stories. Students were introduced to the following vocabulary words: abiotic, biotic, clay, infiltration rate, nitrogen, particle size, permeability, pH, phosphorus, porosity, potassium, sand, and silt. They used the technical information included in their framed paragraphs and reframed it to fit their stories.

To further assist with the construction of their RAFT, students were given time to research the plant they selected for their story. This provided fruitful discussions about whether a website is reliable, such as looking at the number of advertisements on the site and paying attention to the extension (e.g., .com, .gov, .edu, or .org). The research was necessary to expand and enrich their story with facts. The students recorded information such as type of soil needed, nutrients required, amount of water needed, ideal temperature and growing conditions, and the optimal growing location. Students recorded the information they found in their lab notebooks, so they would have it for

FIGURE 2: Storyboard example



their RAFT (Figure 1). On days two through four, we asked the following questions at the conclusion of the activity and students recorded their responses in their science journals:

- What did you observe during my science lab?
- How can you connect your observations from today's readings, lesson, and lab with your own experiences?

Connecting content to relevant literature

On the third day of our program, we read aloud the nonfiction book *A Handful of Dirt* (Bial 2001). Students listened and compared the book to the science investigations and interactive lecture. We then discussed the connections students made with the book and what they had already learned about soil (Ansberry and Morgan 2010). We asked guiding questions, such as "What similarities were mentioned in the text that you also observed in your soil lab? Were there any vocabulary words you did not know? What information from the text do you feel you need to know to continue writing about your seed's journey?"

After the read-aloud, students completed a mechanical analysis of the soil texture (a quantitative method during which the soil sample settles into layers overnight), which was set up the day before (see Resources). This led us into a discussion regarding the effect particle size has on plant growth and water movement, a connection to the nonfiction text. Students related concepts from the book—location of where particular plants were grown and the soil profiles they looked at from these locations—to the lab. In turn, this sparked questions related to the next set of labs on soil permeability, porosity, infiltration, and infiltration rate (see Resources). Students recorded their findings in their science notebooks.

FIGURE 3: Student chart

Chemical parameter	Role in plant growth
pH	Affects availability of soil nutrients to plants
Nitrogen (N)	Key component of chlorophyll, which is essential for photosynthesis
Phosphorous (P)	Needed for metabolic processes that control energy transfer
Potassium (K)	Regulates metabolism and affects cell water pressure

Storyboarding and conferencing

Next, we introduced storyboarding to students as a way to accelerate the writing process. A storyboard is a graphic organizer that displays the images and the text of a story in a sequence to visualize the book layout. After we modeled how to use the storyboard template (see Online Supplemental Materials), students use the template to draft a creative narrative (see Figure 2 for a student example). As students worked, we conferenced with the different student pairs about how to transfer their RAFT writing into the storyboard template. Once students were finished, we analyzed their storyboard templates to give feedback before students finished their story and assembled their text and images into a digital picture book using Google Slides.

On the fourth day, students continued in the lab and conducted chemical tests to determine the pH, nitrogen, phosphorous, and potassium concentrations of their soil sample (see Resources). Students wore goggles and gloves while conducting these tests. They also recorded how these chemicals influence plant growth (see Figure 3). We further elaborated on what occurred if too much or too little of these elements were present in the soil. This lesson reinforced the fact that specific vegetables and fruits require specific growing conditions in terms of the parameters students examined.

The science investigations and research, combined with our feedback, enriched students' storyboards and allowed them to complete their first full drafts of their stories about their fictional seeds. The student pairs made use of our written feedback, our face-to-face verbal clarifications, and feedback from their peers to revise and edit their stories. On the fifth and final day, we again met with each pair and provided additional one-on-one oral feedback to clarify any questions. All 12 groups were eager and motivated to complete their stories. They seemed particularly interested in the storyboard format, which facilitated the visualization of the sequence of events they wanted to include in their stories. We assessed the stories using the rubric we developed and compared scores. The scores were used to inform our practice and curriculum design since this was a summer enrichment program, and students were not assigned grades during the experience.

Classroom implications

Classroom teachers can use the activities and writing strategies we employed to facilitate their students' scientific understandings and develop their writing

FIGURE 4: Daily reflection rubric

	Excellent 4	Acceptable 3	Weak 2	Inadequate 1
Responses to guiding questions	Responses are thorough and reflect full understanding of the lesson.	Responses are acceptable and reflect some understanding of the lesson.	Not all responses are acceptable, and they reflect little understanding of the lesson.	Responses clearly reflect that there is minimal/no understanding of the lesson.
Vocabulary and/or concepts	Reflection incorporates and demonstrates comprehension of all the vocabulary and concepts from the lesson and/or lab.	Reflection incorporates and demonstrates comprehension of most of the vocabulary and concepts from the lesson and/or lab.	Reflection incorporates and demonstrates comprehension of some vocabulary and concepts from the lesson and/or lab.	Reflection does not incorporate nor demonstrate comprehension of any vocabulary or concepts from the lesson or lab.
Learning statement	Reflection includes clear and complete statements about what was learned.	Reflection includes brief statements about what was learned.	Reflection includes incomplete statements about what was learned.	Reflection does not include statements about what was learned.
Grammar	Grammar is usually correct with few mistakes. Meaning is clear.	Grammar usage is inconsistent, but mistakes mostly do not interfere with meaning.	Grammar usage is inappropriate. Mistakes interfere with meaning.	Grammar usage shows serious problems. Meaning is unclear.
Spelling	Spelling of new, difficult words is sometimes incorrect, but spelling of grade-level vocabulary is correct.	Spelling of new, difficult words is often incorrect, but spelling of grade-level vocabulary is mostly correct.	Spelling of new, difficult words and grade-level vocabulary are often incorrect, but mistakes mostly do not interfere with meaning.	Spelling of new, difficult words and grade-level vocabulary are often incorrect. Meaning is unclear.
Total score				

skills. Though the digital children's story served as a summative assessment of students' understanding (see Resources for an example of a children's story), we also wanted students to reflect on the science investigations and the research they had conducted. In this regard, we gave students guiding questions at the end of each lab session. We also asked a final synthesis question to students about whether their soil sample (from our laboratory investigations) was adequate for growing the chosen fruit or vegetable from their children's story. We developed a rubric (see Figure 4) for classroom teachers to access reflective writing activities such as these in their classrooms. Hopefully, this type of integration will lead to more students building science and writing skills in interesting, enjoyable, and fascinating projects. ●

ONLINE SUPPLEMENTAL MATERIALS

Framed paragraph activity, storyboard template—*www.nsta.org/scope0719*

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RESOURCES

Children's story example—*https://goo.gl/Rdr6cf*

Google Map for *Radio Man*—*https://goo.gl/LR1pNX*

Math problems based on *Radio Man*—*https://goo.gl/VNDFNP*

Porosity, permeability, and infiltration rate labs—*https://goo.gl/ZFK1Zx*

Soil chemical testing lab—*https://goo.gl/tjDKqq*

Soil collection datasheet—*https://goo.gl/KJOhHQ*

Soil observation data table—*https://goo.gl/alYFFE*

Soil texture labs—*https://goo.gl/qyajbx*

Soilweb Interactive Google Map—*https://casoilresource.lawr.ucdavis.edu/soilweb-apps/*

Whole-class data table on Google Sheets—*https://goo.gl/wTyFTp*

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013)

- The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.
- The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectations listed below.

Standard

MS-LS1: From Molecules to Organisms: Structures and Processes
www.nextgenscience.org/dci-arrangement/ms-ls1-molecules-organisms-structures-and-processes

Performance Expectation

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

DIMENSIONS	CLASSROOM CONNECTIONS
Science and Engineering Practices	
Planning and Carrying Out Investigations	Students perform laboratory investigations on local soil samples to determine texture, pH, nitrogen, phosphorus, and potassium.
Analyzing and Interpreting Data	Students analyze and interpret data sets from chemical tests to determine whether a soil sample would support plant growth.
Obtaining, Evaluating, and Communicating Information	Students gather evidence from laboratory investigations, interactive lecture, and internet research to write a digital short story.
Disciplinary Core Idea	
LS1.B: Growth and Development of Organisms • Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)	Students evaluate how local soil conditions affect the growth of plants.
Crosscutting Concept	
Structure and Function	Students discover the role various soil properties play in plant growth and water movement through laboratory investigations.

Connections to the *Common Core State Standards* (NGAC and CCSSO 2010)

ELA

WHST.6-8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-LS1-1)

SL.8.5. Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2),(MS-LS1-7)

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