CASE STUDY 4

English Language Learners and the Next Generation Science Standards

Abstract

The number of English language learners in schools across the nation has increased dramatically over the past decade. At the same time the gap in science proficiency between English language learners and non-English language learners has widened. As a result of Elementary and Secondary Education Act (ESEA) legislation, school districts are held more accountable for English language learners' progress and must seek ways to provide equal access to education. The Next Generation Science Standards sets higher expectations in science for all students, and teachers of English language learners must employ effective strategies to deepen understanding of science while learning English. The literature indicates five areas where teachers can support science and language for English language learners: (1) literacy strategies for all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections. The vignette highlights how these strategies promote English language learners' understanding of disciplinary core ideas, scientific and engineering practices, and crosscutting concepts as described by the Next Generation Science Standards.

Vignette: Developing and Using Models to Represent Earth's Surface Systems

While the vignette presents real classroom experiences of NGSS implementation with diverse student groups, the following considerations should be kept in mind. First, for the purpose of illustration only, the vignette is focused on a limited number of performance expectations. It should not be viewed as showing all instruction necessary to prepare students to fully understand these performance expectations. Neither does it indicate that the performance expectations should be taught one at a time. Second, science instruction should take into account that student understanding builds over time and that some topics or ideas require extended revisiting through the course of a year. Performance expectations will be realized by utilizing coherent connections among disciplinary core ideas, scientific and engineering practices, and crosscutting concepts within the NGSS. Finally, the vignette is intended to illustrate specific contexts. It is not meant to imply that students fit solely into one demographic subgroup, but rather it is intended to illustrate practical strategies to engage all students in the NGSS.

Introduction

The scientific and engineering practices described in the NGSS are language intensive and present both language demands and language learning opportunities for English language learners. This vignette illustrates how very young students, many of whom are English language learners, can develop proficiency in these language intensive scientific practices while engaging with rigorous science content. With a focus on Earth science, the teacher powerfully demonstrates how her students overcome language barriers to use models, develop claims, and explain their reasoning using evidence. The vignette highlights effective strategies to provide English language learners' access to core ideas, practices, and crosscutting concepts of science.

Throughout the vignette, classroom strategies that are effective for all students, particularly for English language learners according to the research literature, are highlighted in parentheses.

ELL Connections

Like all of the classes at Monroe Elementary, a school with more than 74% of the population at or below the poverty level, Ms. H.'s 2nd grade class was made up of diverse groups of learners. Her class included three Hmong students, eight African-Americans, three students who recently arrived from Gambia, two from Mexico, and two Mexican-Americans. Of her eighteen children, nine were English language learners.

Three weeks into the Earth science unit, Ms. H. introduced a task in which students had to rely on their team members, their field notes (Figure 1), and their diagrams of soil profiles to match three different types of soil to their source locations. Each team of three students had paper plates piled with soil on the table in front of them and three location cards. The unidentified soil samples came from sites within walking distance of Monroe School. One card was labeled "Urban Marsh" and had a picture of the marsh near the school. The other cards were labeled "Coniferous Hill" and "School Yard Field" with respective photos. *(Ms. H. used these labeled cards with photos to represent concepts as a language support strategy for English language learners.)*

Throughout the unit, each team had dug small soil pits in the three locations, recorded data about soil composition and function (e.g., infiltration), and designed, to scale, diagrams of soil profiles for each site. (Practices: Analyzing and Interpreting Data, and Using Mathematics and Computational Thinking.) Now, with their teams, they were making claims, looking for evidence to support their claims, and recording their reasoning on large white boards. (Practice: Engaging in Argument from Evidence.)

One group—Kaleem, Moustafa and Victor—was working closely together. Kaleem consulted his partners, who were sifting through one of the soil samples and looking for clues. "Feel this! Feel this, you guys; this is so sandy. Here feel." He handed one of the plates of soil to Victor. "Don't you think that is sandy?" He looked at the open page in his science notebook: the class had previously tested and written about the compositions of different soils.

Victor and Moustafa were focused on something they had discovered in one of the soils, pine needles. Moustafa, a recent newcomer from Gambia, said, "This is, this thing, this is…" He held up the pine needles. Kaleem supplied the word, "pine needle?" Then Kaleem added dramatically, "Oh! Coniferous hill."

The boys tramped over to the wall sized diagrams that the class had made of the soil profiles for each location. These diagrams served as models to help the students think about and explain differences in soil. Only one of the soil profiles showed pine needles in the soil, and that was the coniferous hill. Victor looked at his coniferous hill notes, "There are small roots three (*inches*) down. And pine needles one (*inch*) down." Victor used the team's field notes to reinforce his thinking about the type of soil.

Moustafa pointed to the colors on another adjacent model, "And the soil was dark, dark, dark black, and it looks like black." Kaleem responded to Moustafa, "What do you mean?" Moustafa said, pointing to the soil and running his finger along the soil profile for the urban marsh, "Here, urban marsh, it is wet soil, dark, dark black." He looked for the label 'organic' on the diagram, found it, and added, "Organic soil." Mustafa's specialization was the urban marsh; his group members knew this and nodded appreciatively. Focusing on the colors of the soil on the paper plates, they looked for the darkest soil from the urban march. They were well on their way to solving the mystery. (Practice: Developing and Using Models.)

Each member of the three-person teams had developed expertise in a different soil site. Earlier, Moustafa and his fellow "urban marsh specialists" had studied the marsh and its soil, and refined the class model of the urban marsh. The "urban marsh specialists" had read books from the library, written and drawn about their site in their science notebooks, and presented their findings to the class. (Practice: Obtaining, Evaluating, and Communicating Information.) Now he was working with Victor and Kaleem, experts from each of the other sites, on the problem of matching the soils to their locations. The team depended on each member's knowledge to aggregate all the evidence the group needed to support their claims. Ms. H. often used the jigsaw format to fuel contributions of her English language learners. *(The jigsaw is an example of an effective discourse strategy for English language learners.)* Since every student possessed unique and vital information, the format validated each student's contribution.

With Kaleem and Moustafa's help, Victor, the "coniferous hill specialist," used the sentence frame: "This soil came from __*site*___ because__ *evidence*_____" to write his explanation on the white board under plate #2. As the students had taken care to clearly and correctly label all of the elements on the model, Victor double-checked his spelling against the model labels: "*This soil came from the coniferous hill because it shows there is pine needles at that place and there is pine needles in the dirt*." Victor and his team needed to come up with two more pieces of evidence to support this claim. (Practice: Engaging in Argument from Evidence.)

How did Ms. H. help her students become so interested in soil? Ms. H. began her unit, three weeks previously, by soliciting prior knowledge. She had the students collect a small sample of soil from the schoolyard field in paper cups, bring it into the classroom, and describe the soil to their partners. Ms. H. recorded their observations in a conceptual web to organize thinking and build schema about the topic. *(The conceptual web is an effective literacy development strategy for English language learners.)* She had four categories for the web: "where soil is; what soil looks, feels and smells like; what soil is made of; and experiences with soil." Students took turns passing the squishy ball around the circle, sharing ideas and questions about soil, or choosing to pass. If a student asked a question, Ms. H. wrote the question on a sentence strip and taped it on the cabinet under the heading, "Scientific Questions about Soil."

She had been delighted to see that everyone had at least one question or idea to share. Moustafa shared that the soil was black, brown and white. Some kids shared experiences with soil in a garden, and others talked about worms. Julissa asked, "How does soil grow?" And Edrissa asked, "Does soil come from rocks?" When the list was exhausted, each student chose one idea to draw and illustrate in their science notebooks; some students had time to write down two or three.

The next day Ms. H. taped a sentence strip after the words "Scientific Question" on the white board: "Is soil the same everywhere?" The class used "turn and talk" to discuss the question with their partners. Ms. H. made sure that students with similar language backgrounds had the opportunity to discuss the question in their home language or English. *(English language learners benefit from home language support in the classroom.)* Each student's goal was listening to the partner. Ms. H. asked, "Did everyone get a chance to share?" and then added, "You have one more minute." Two students needed to switch listener and speaker roles. She picked three craft sticks with the students' names on them, placed the names on the carpet for all to read, and asked, "What did your partner say?"

Trinique's name was picked first and she said, "My partner Deshawna said that soil is not the same everywhere because it feels different at the beach." Ms. H. checked with Deshawna, "Is that what you said, Deshawna?" who nodded and added, "It is rough, sand feels rough and scratchy." Ms. H. wrote under the scientific question, "Soil at the beach feels rough." After soliciting two more responses, Ms. H. asked students to draw and write about the scientific question: "Is soil the same everywhere?" in their science notebooks.

The conceptual web from the day before became very helpful to the students as they used it to find vocabulary and check spelling. Jesus, an English language learner, wrote, "Soil are different place like Canada, New York and Florida because there are different towns, city, or country." Zytasia wrote, "No, because there's hard soil and fresh soil, because I saw white soil and black soil."

The scientific question written in students' home language was assigned for homework so that they could talk about the question with their parents. Students were permitted to fill in the answer in their home language or English. Ms. H. often asked the students to conduct parent interviews because she wanted to spark discussions at home. *(English language learners benefit from home language support in the classroom.)* Ms. H. was able to construct new meaning with the resources her students brought, as many students had important thoughts and questions that they could discuss using the rich science-specific vocabulary in their home language.

When the students shared their parent interviews with their classmates, the answers varied from "no, soil comes in different bags," to an answer written in meticulous printing, "Gambia - the soil is red and dusty, some places have good soft clay and are good for farming." One Hmong boy talked to his family and asked the school's translator to write their answer in Hmong and English, "Not the same. Some soil is sticky (clay), some is dry. Some soil is black and some is yellow." Jesus's mom had helped him write her answer in Spanish, and he proudly read it to the class. "*No, no es igual porque en unos lugares la tierra es seca y dura y en otros lugares es húmeda.*" Based on the interviews, it was clear that the homework assignment allowed students to have meaningful conversations with their parents about soil and reinforced the relevance of science in their lives. (*The homework assignment highlights home culture connection to science by capitalizing on funds of knowledge from the students' homes and communities.*)

Ms. H. personally invited parents to stop in at any time and share their experiences about soil. She asked the school translator to make some of the calls. Mrs. Xiong, Chou's grandmother, came to the class to speak. Because she spoke Hmong, Mrs. Xiong spoke to the class through the school's interpreter. She compared the rich soil in Laos to the sandy soil in the Midwest and marveled that corn could grow at all in the local soil. "It's raining in Laos pretty much all the time so the soil is pretty much rich. It rains so much the forest holds everything together and holds the nutrients. It doesn't wash out. Over there we don't have sandy soil. In this area, I was so surprised to see corn growing in rows in the sandy soil. You walk in loose sandy soil. People say that sandy soil is not good soil, because plants like clay soil. Here, every year I thought the corn would never set, but it was good every season." The class had a lot of questions for Mrs. Xiong. They were interested in her comparisons of the fertilization techniques her family used in both countries. Some of the students were surprised to learn that there are worms in such a faraway country.

After sharing the parent interviews and hearing Mrs. Xiong's presentation, the class was convinced that soil was different in different places, but they wanted to be sure that this was true for soil from different places in their neighborhood, too. Ms. H. tried to center her science investigations in culturally relevant contexts, in this case their neighborhood. (*This "place-based" strategy established connections between school science and the students' community and lives.*)

Ms. H. encouraged students to gather physical evidence for their claim that "soil was different in different places." They decided that the best way to support their claim was to observe soil taken from different places near the school. (Practice: Planning and Carrying Out Investigations.) They used a topographical map and an aerial photo map of the neighborhood to determine soil sites that seemed different: a hill, the marsh, and the school yard. They noticed that the sites had different trees—deciduous trees, no trees, and coniferous trees—and they also had different elevations. (DCI: K-2-ESS2.B Earth's Systems.) It was at these sites that the students collected and investigated the soil, forming the basis for comparisons based on evidence and the soil profile diagrams each group constructed.

The following week, Ms. H. helped her students think in terms of patterns when exploring similarities and differences in the soil in the neighborhood. (CCC: Patterns.) The students observed the soil color, texture, smell, and infiltration and collected data about the organisms in the soil. They learned a lot about patterns in soil composition. (DCI: PS1.A Structure and Properties of Matter.) Among other things, they learned that soil can be made up of sand, silt, clay and organic materials, and that plants and animals are found in soil made with organic material. They discovered that sand has larger particles than silt and clay, and settles more quickly when it is in slowly moving water. (CCC: Energy and Matter.) Some students were beginning to apply these ideas to the urban marsh soil with much more organic material and coarser (sandy) mineral composition. The soil at the urban marsh had a lot more sand than the other two sites, partly due to rainwater flowing in from the streets that were sanded during icy conditions. Trash, too, had collected in the urban marsh for similar reasons. The students witnessed trash blowing and collecting in the marsh during their fieldwork. Also, on the topographical map, they saw that the urban marsh was one of the lowest places in their neighborhood. Ms. H. wrote each piece of evidence on the white board.

Ms. H. read the scientific question slowly and posted it on the board: "How does wind and water CHANGE the urban marsh soil?" (DCI: K-2-ESS2.A Earth's Systems.) She used gestures while she spoke to show wind and water. After a "turn and talk" and a brief discussion, she used "stop the music" to get her students to talk to more than one student about their thinking. The students moved around the room, and when the music stopped, they gathered in twos and threes and each shared. They had time to jot down whom they talked to and one thing they had discussed.

Jesus searched for words to explain how wind and water changes the urban marsh soil, "Water goes down, and because the coniferous had a hill and the urban marsh is down the hill and then the water. When people throw garbage in there and when the rain comes, it takes the garbage and put it in the urban marsh. And when the wind takes trash, when the wind comes, it throws the trash and it goes under and goes into the urban marsh." Pao responded, "Yeah, 'cause the wind blows the garbage." She showed what the wind did with her hands sweeping imaginary garbage.

Trinique was speaking with Moustafa and Kaleem. She said, "The sand is heavy and goes down in the water, not the clay! The clay floats away." Kaleem expanded on Trinique's idea, "Because like the water can float, some stuff, that they can pick up stuff that are light and heavy and going down." Moustafa confidently added a new idea, "Yes, the wind move it too, garbage.

The wind float it away." (CCC: Stability and Change.) The students used the concept of change to help understand and talk about the effect of the wind and water on the marsh soil.

All the students had time to write down and share their reasoning about the scientific question. Now they were ready to have a class discussion and felt comfortable expressing their ideas to the class.

The next day, Ms. H. asked the students, "How can we stop wind and rain from changing the urban marsh soil?" She asked the students to work on this question independently, first by drawing and then by explaining their drawing in writing. (DCI: K-2-ETS1.B Engineering Design.) When they worked independently, students came up with original ideas. Ms. H. noticed that many students tried to solve either the wind or the water problem, but not both. Pao drew a line of people holding up umbrellas over the urban marsh. Zytasia drew holes around the urban marsh that collected the garbage and sand. Moustafa thought that he could build a giant wall around the urban marsh. Victor drew a tent that completely covered the marsh. Kaleem considered an unusual solution; he sketched signs on the road, "Throw away your garbage!" and "Don't put sand on the road!" (Practice: Constructing Explanations and Designing Solutions.)

When the students finished their drawings and explanations of their designs, Ms. H. suggested "a museum walk" to share student ideas. She asked students to move around the room and use sticky notes to comment on each other's design presentations. Later, students went back to their own designs, read the comments, and refined their designs accordingly. (DCI: K-2-ETS1.C Engineering Design.)

NGSS Connections

The NGSS promotes a vision of science learning by blending disciplinary core ideas, scientific and engineering practices, and crosscutting concepts. This vignette provides a snapshot of scientific practices and how disciplinary core ideas can be made accessible to English language learners by expanding on a crosscutting concept, patterns, that the students may have encountered in other studies. During the course of the six-week quarter (including lessons not described in this vignette), the students had opportunities to develop proficiency in all of the performance expectations in 2.ESS2, Earth's Surface System. The following performance expectations were highlighted in the vignette:

2. Performance Expectations

2-ESS2-1 Earth's Surface Systems: Processes that Shape the Earth
Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

2-ESS2-2 Earth's Surface Systems: Processes that Shape the Earth
Develop a model to represent the shapes and kinds of land and bodies of water in an area.

2-PS1-1 Matter and its Interactions
Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

K-2-ETS1 Engineering Design
Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

Disciplinary Core Ideas

ESS2.A Earth Materials and Systems
Wind and water can change the shape of the land.

ESS2.B Plate Tectonics and Large-Scale System Interactions
Maps show where things are located. One can map the shapes and kinds of land and water in any area.

PS1.A Structure and Properties of Matter
Matter can be described and classified by its observable properties.

ETS1.B Developing Possible Solutions
Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solution to other people.

ETS1.C Optimizing the Design Solution
Because there is always more than one solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.

In the unit, the students developed understandings of core ideas in earth science and physical science. Learning about the deposition of road sand in urban marsh in the familiar context became a catalyst for discussing water as a factor in the transportation of earth materials in other settings. The students used their soil profile models to describe the layers of soil types, and classified the soil by observable properties. Also, students were challenged to design engineering solutions to mitigate road sand deposition in the marsh.

Scientific and Engineering Practices

Developing and Using Models
Develop a model to represent patterns in the natural world.

Constructing Explanations and Designing Solutions
Make observations (first hand or from media) to construct an evidence-based account for natural phenomena.

Compare multiple solutions to a problem.

Planning and carrying out Investigations
Plan and conduct an investigation collaboratively to produce data to serve as a basis for evidence to answer a question.

During the six-week investigation, the students engaged in all eight of the scientific practices. This vignette highlighted the use of *developing models.* The students refined and expanded their soil profile models to explore patterns as they developed understanding of Earth's surface systems. The teacher provided various entry points for all students to engage in the scientific practice of *constructing explanations and designing solutions*. As students constructed their explanations, she relied on collaborative group activities to help students gather evidence and make claims based on the evidence. She also included individual writing and presentations to design engineering solutions, and the students applied this practice in multiple formats. Finally, the students *planned and carried out an investigation* with support, centered on gathering evidence to address the question, "Is a soil the same?"

Crosscutting Concepts

Patterns
Patterns in a natural world can be observed.

Stability and Change
Some things stay the same while other things change.

Energy and Matter
Objects may break into smaller pieces and be put together into larger pieces, change shapes.

The crosscutting concepts of *patterns* and *stability and change* are overarching ideas in this unit, and *energy and matter* was a focus during the investigations of the physical properties of soil. The teacher encouraged the students to think about their scientific experiences with soil in terms of patterns when she posed questions about the similarities and differences in the soil in their neighborhood. The students noticed a pattern in the prevalence of organisms in certain types of soil, and noted the presence of worms, insects and other living creatures in some soil types but not in others. They observed that water filtration was also connected to the soil type. They also found a pattern in the amount of organic material in the soil and its elevation. The students learned that changes, as in the slow changes indicated by the soil layers and faster changes caused by salt deposits on the road, are a valuable way to think about soil. In this way, Ms. H.'s students gradually developed an understanding of how the crosscutting concepts of patterns, and stability and change, apply to earth science.

CCSS Connections to English Language Arts and Mathematics

The NGSS is committed to addressing the Common Core State Standards for ELA and math as an integrated part of science. English language learners develop mastery of the language of ELA and math when they engage in these subject areas in a meaningful context and for an authentic purpose. The vignette highlighted the teacher's incorporation of the CCSS for ELA. Within the larger context of earth science, the students collaborated to problem solve and develop claims, evidence, and reasoning in small and large groups.

- **SL.2.1** *Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and large groups.*

Students also addressed the CCSS for math as part of their evidence gathering. The unit repeatedly focused on this standard in preparation for and part of data collection and development of the soil profile models.

- **2MD.1** *Measure and estimate lengths in standard units: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.*

Effective Strategies from Research Literature

The NGSS scientific and engineering practices are language intensive and require students to engage in classroom science discourse. Students must read, write, view and visually represent as they develop their models and explanations of scientific phenomena. They speak and listen as they present their ideas or engage in reasoned argumentation with others to refine their ideas and reach shared conclusions. These practices offer rich opportunities and demands for language learning at the same time as they support science learning (Lee, Quinn, & Valdés, in press). The literature indicates five areas where teachers can support science and language for English language learners: (1) literacy strategies with all students, (2) language support strategies with English language learners, (3) discourse strategies with English language learners, (4) home language support, and (5) home culture connections (Fathman & Crowther 2006; Lee & Buxton, 2013; Rosebery & Warren 2008).

First, teachers highlight various strategies for literacy development (reading and writing), such as activating prior knowledge, having explicit discussion of reading strategies for scientific texts, prompting students to use academic language functions (e.g., *describe*, *explain*, *predict*, *infer*, *conclude*) for science and engineering, engaging students in scientific genres of writing (e.g., keeping a science journal), teaching the uses of graphic organizers (e.g., concept map, word wall, Venn diagram), and encouraging reading trade books or literature with scientific themes.

Second, teachers provide language support strategies with English language learners, typically identified as English for Speakers of Other Languages (ESOL) strategies. They use hands-on activities, realia (real objects or events), and multiple modes of representation (gestural, oral, pictorial, graphic, textual). They guide students to comprehend key science vocabulary in context – both general academic terms and discipline specific terms.

Third, discourse strategies focus specifically on the teacher's role in facilitating English language learners' participation in classroom discussion to enhance their understanding of academic content (i.e., adjust the level and mode of communication). A major challenge for teachers is in how to structure activities so as to reduce the language barrier for participation while maintaining the rigor of science content and processes.

Fourth, teachers can build upon and make use of students' home language to support science learning in English. Teachers may introduce key science terminology in both the home language and English, highlight cognates as well as false cognates between English and the home language, allow code-switching, and encourage bilingual students to assist less English proficient students in home language.

Finally, to connect science to students' home culture, teachers need to understand that students participate in classroom interactions in ways that reflect culturally-based communication and interaction patterns from their home and community. In addition, they need to elicit students' "funds of knowledge" related to science topics and use students' cultural artifacts and community resources in ways that are academically meaningful and culturally relevant.

Context

Demographics

The number of school-age children (ages 5-17) who spoke a language other than English at home rose from 4.7 million to 11.2 million between 1980 and 2009, or from 10% to 21% of the population in this age range (National Center for Education Statistics [NCES], 2011). Currently, over one in five students (21%) speak a language other than English at home, and limited English Proficient (LEP) students (the federal term) have more than doubled from 5% in 1993 to 11% in 2007. This statistic does not include students who were classified as English language learners when younger but who are now considered fluent English speakers.

Although Spanish speakers make up the majority of the ELL population in the U.S., there are over 400 different languages spoken by U.S. students (U.S. Census Bureau, 2011). In 2009, of the total number of students ages 5-17 who spoke a language other than English in the home or spoke English with difficulty, 73.5% spoke Spanish, 10.5% spoke an Indo-European language, 12.6% spoke an Asian or Pacific Islander language, and 3.5% spoke other languages (U.S. Census Bureau, 2011). Public schools in the nation's urban areas have more English language learners (14% on average) than schools in suburban areas (8%), towns (7%), or rural areas (4%) (NCES, 2009). English language learners are comprised of foreign born and US citizens; 80% of elementary school English language learners are born in the United States (IU Newsroom, 2008).

Science Achievement

Science achievement of English language learners continues to fall behind non-English language learners. For example, based on the 2009 National Assessment of Educational Progress (NAEP) science scores, only 3% of ELL 8th graders scored proficient on the science achievement assessment, compared to 34% of non-English language learners. In the same year, 17% of 8th grade English language learners scored basic or above, compared to 68% of non-English language learners (NAEP, 2011). The science achievement gaps between ELL and non-English language learners widened considerably from 2005 to 2009 for 4th, 8th, and 12th graders. According to the 2009 NAEP science results using 300-point scale scores, the gaps were 40 points for 4th graders, 50 points for 8th graders, and 47 points for 12th graders. These widening gaps were a reversal of the trend from the previous decade, in which gaps narrowed somewhat from 1996 to 2005 for 4th and 8th graders.

NAEP does not break down ELL science scores by language group, type of district (urban, suburban, towns, or rural), or origin (U.S. vs. foreign-born).

Before 1996, NEAP did not offer any accommodations for English language learners and students who could not meaningfully participate in the assessment were excluded (National Center for Educational Statistics, 2013). The NAEP science assessments conducted in 1996, 2000, 2005, and 2009 included accommodations such as extended time, test items read aloud in English or Spanish, translated assessments, and Bilingual dictionaries and glossaries. Unfortunately, the lack of consistent policy regarding the participation of English language learners produced wide variability in exclusion rates making it difficult to meaningfully assess ELL growth. In 2010, in an effort to be more inclusive, NAEP implemented a new policy that extended accommodations to all English language learners and enforced higher (85%) inclusion rates.

Educational Policy

Part A of Title III of the Elementary and Secondary Education Act, the English Language Acquisition, Language Enhancement and Academic Achievement Act, provides for monitoring English language learners for Adequate Yearly Progress (AYP) in English language proficiency and content areas. This Act emphasizes increased accountability of English language learners in content-based academics and delivers funding according to each school's ability to meet AYP.

To measure progress, each state is required to implement English language proficiency tests based on its English language proficiency standards, which in turn are linked to the state's academic standards. Proficiency levels (usually ranging from limited proficiency to proficient) must be established to measure progress; however, these levels are not consistently defined across states. Even though 28 states have adopted WIDA (World Class Instructional Design) to monitor progress, there is little consistency nation-wide. As definitions of ELL, goals for ELL achievement (AYP), and monitoring tools vary, it is impossible to compare ELL performance across states.

Content area assessment and measures of AYP for English language learners cannot be separated from the language programs that serve students, also dictated by state policy. If a state supports bilingual education, then it is likely that at least some portion of instruction is conducted in the students' home language while they are developing academic language proficiency in English. In states that follow an "English only" policy for English language learners, then all science instruction takes place in their second language and science knowledge has to be developed concurrently with academic English. Overall, educational policy for English language learners has been moving away from bilingual education and multicultural perspectives, and toward English proficiency and accountability for standards-based content learning.

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K-2-ETS1 Engineering Design

2. Earth's Surface Systems: Processes that shape the Earth

2-PS1 Matter and its Interactions

Students who demonstrate understanding can:

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind and 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-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

k-2-ETS1-1. Ask questions, make observation, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improves object or tool.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in K-2 builds on prior experiences and progresses to include using, and developing models that represent concrete objects or design solutions.

- Develop a model to represent patterns in the natural world.

Constructing Explanations and designing Solutions.
Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence or ideas in constructing explanations and designing solutions.

- Compare multiple solutions to a problem.

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- Wind and water can change the shape of the land.

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Maps show where things are located. One can map the shapes and kinds of land and water in any area.

ETS1.C Optimizing the Design Solution

- Because there is always more than one solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.

PS1.A: Structure and Properties of Matter

- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.

Crosscutting Concepts

Patterns

- Patterns in the natural world can be observed.

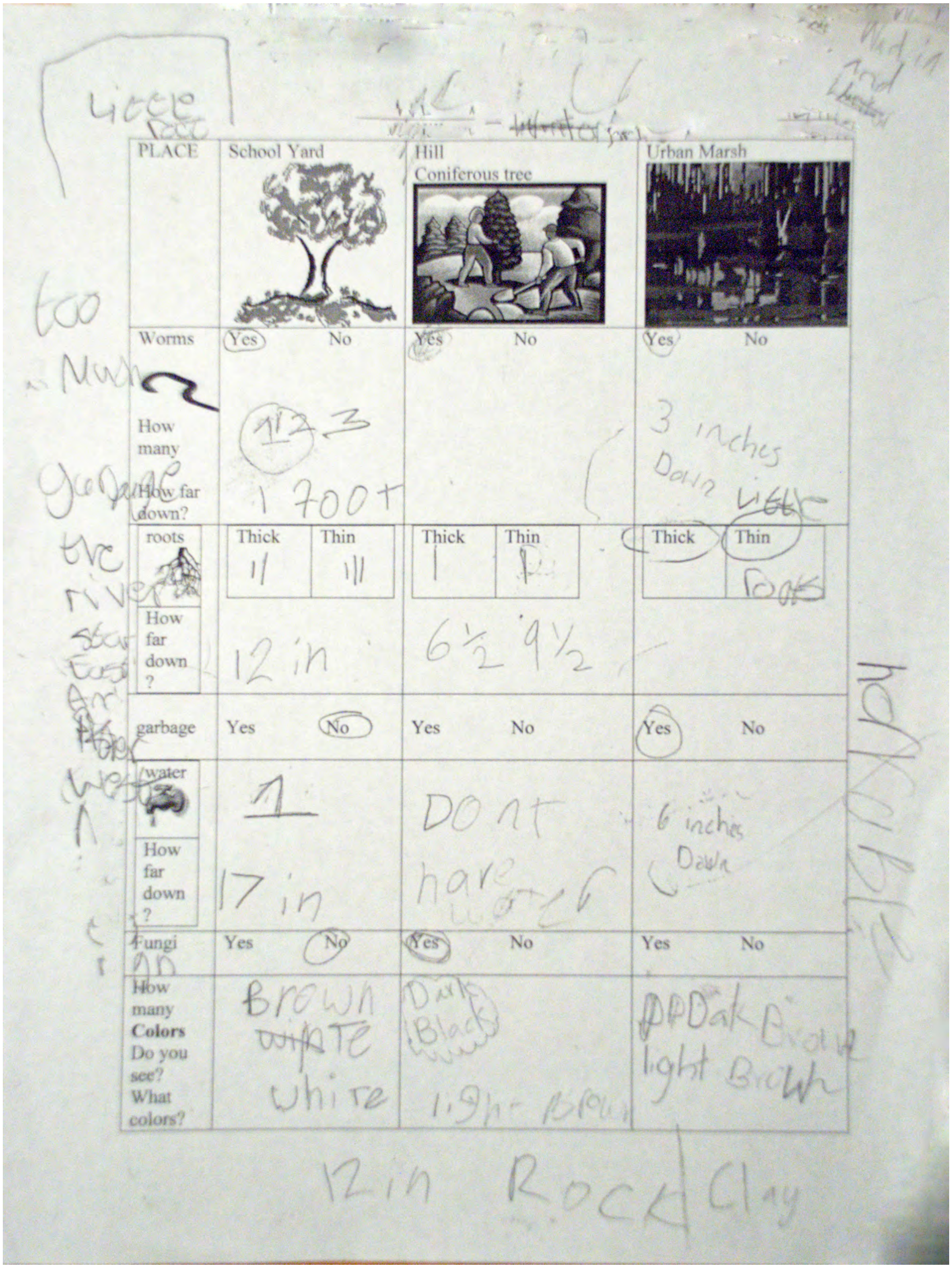
Stability and Change

- Some things stay the same while other things change.

Energy and Matter

- Objects may break into smaller pieces and be put together into larger pieces, or change shapes.

CCSS Connections for ELA and Mathematics
SL.2.1 *Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and large groups.*
2MD.1 *in Measure and estimate lengths in standard units: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.*



PLACE	School Yard	Hill Coniferous tree	Urban Marsh
Worms How many How far down?	Yes No 1 2 3 1 foot	Yes No	Yes No 3 inches Down little
roots How far down?	Thick 11 / Thin 111 12 in	Thick 1 / Thin 1 6 1/2 9 1/2	Thick / Thin roots
garbage	Yes No	Yes No	Yes No
water How far down?	1 17 in	Dont have water	6 inches Down
Fungi	Yes No	Yes No	Yes No
How many Colors Do you see? What colors?	Brown ~~white~~ white	Dark Black light Brown	Dark Brown light Brown

12 in Rock Clay

Figure 1. Field notes.

Figure 2. Student generated models of soil profiles.