

From Homes to Classrooms: Cultural Wisdom as a Guide for STEM Lesson Planning

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ABSTRACT

This article describes innovative elementary science instructional approaches based on cultural wisdom developed by preservice teachers enrolled in a teacher preparation program at a university in the U.S.-Mexico border region. As a part of a larger study, three Latina preservice elementary teachers were a part of a teacher residency in conducting community interviews and reflection activities to uncover cultural backgrounds that could inform culturally sustaining STEM lesson planning, centering on family and home knowledge. This project began with family interviews during winter break and culminated in lesson planning and implementation during their science methods course in the spring semester. The project was grounded in culturally sustaining pedagogy, Funds of Knowledge, and *nepantla* as theoretical frameworks. The authors analyzed how preservice teachers transformed cultural practices into engaging science learning opportunities. Through this process, PSTs developed a deeper understanding of culturally sustaining pedagogy. They learned to position students' home knowledge and their own as scientific capital rather than viewing cultural differences through deficit perspectives. The project resulted in the repositioning of cultural knowledge as scientific capital, the development of culturally sustaining STEM practices that bridged home and school science, and the fostering of critical consciousness in teacher preparation. The findings demonstrate how cultural wisdom serves as a powerful foundation for meaningful STEM education, particularly for underrepresented students in bicultural communities. Implications include integrating ethnographic inquiry into teacher preparation, developing multilingual pedagogical approaches, and centering family voices as co-educators in culturally sustaining instruction.

Keywords: funds of knowledge, STEM education, elementary preservice teachers, border communities, cultural wisdom, teacher preparation

Introduction

In the evolving landscape of science education, there is a growing recognition that student diversity should be viewed as a resource for learning rather than a barrier to overcome. Traditional approaches have too often operated from deficit perspectives, focusing on what students lack rather than the rich knowledge systems they bring from their homes and communities (Barton, 2003; St. Clair & McNulty, 2021). This shift toward asset-based pedagogies is exemplified in border communities, where students navigate multiple cultural and linguistic worlds daily.

Culturally sustaining pedagogy (Paris, 2012; Paris & Alim, 2017) aims to sustain students' cultural assets rather than replace them. This aligns with the concept of Funds of Knowledge (FoK), developed by Moll et al. (1992), which provides a powerful framework for understanding how students' social connections, activities, and cultural practices represent distributed knowledge systems that can enhance classroom learning. When combined with *nepantla* (Anzaldúa, 1987), teachers can build pedagogical bridges that honor students' knowledge from home, rather than conceptualizing this knowledge as a deficit to be corrected. As Heineke and McTighe (2019) demonstrate, integrating students' cultural and linguistic assets into instructional design creates more inclusive and effective learning environments and embeds content relevance for students. Extant research demonstrates that integrating students' native languages with scientific vocabulary enhances learning outcomes. Chapman and McHatton (2022) emphasize using native language to scaffold scientific understanding, while Chapman et al. (2022) and Chapman et al. (2017) show that incorporating Spanish language strategies in science instruction significantly improves academic achievement for bilingual learners.

Recent scholarship in science teacher education has explored innovative approaches to connecting home and school knowledge. Medina-Jerez and Dura (2020) illustrated how food pedagogy can serve as a bridge between cultural practices and scientific concepts, while St. Clair and McNulty (2021) provided practical examples of how to leverage students' FoK in secondary science classrooms. Extending this to teacher preparation, Ortiz (2024) found that a culturally sustaining science curriculum helped preservice teachers connect their own home and community knowledge of nutrition and wellness to academic science concepts. These approaches reflect what Paris and Alim (2017) describe as culturally sustaining pedagogy or teaching that draws upon cultural knowledge and actively works to maintain and foster it.

The pedagogical innovations in this manuscript extend this body of literature by examining how preservice teachers can learn to center cultural wisdom in STEM lesson planning, not only by drawing on students' cultural knowledge but also by locating and valuing it within students' home and community contexts. Working in a U.S.-México border region, we engaged three Latina preservice teachers (PSTs) enrolled in a science methods course to conduct family interviews as the foundation for designing and implementing culturally sustaining lessons that honor students' cultural assets while maintaining academic rigor. Through the lens of *nepantla*, Anzaldúa's (1987) concept of transformative in-between spaces, this paper explores how teachers can create pedagogical bridges between home and school knowledge systems.

Theoretical Frameworks

This project is grounded in three interconnected theoretical frameworks that guided PSTs' curriculum development. First, CSP (Paris, 2012; Paris & Alim, 2017) emphasizes that effective teaching engages students' culture as an element to be sustained, rather than replaced. This framework guided our approach to centering students' cultural backgrounds as assets rather than deficits in lesson design.

Second, we drew extensively on the Funds of Knowledge framework (Moll et al., 1992; González et al., 2005), which assumes that students bring valuable knowledge from their homes and communities that can be built upon in classroom instruction. This perspective recognizes cultural practices, knowledge, and skills embedded in households as legitimate intellectual resources for teaching and learning. We positioned family interviews as mechanisms for uncovering these rich knowledge systems and translating them into pedagogical resources.

Third, the concept of *nepantla*, meaning *in the middle* in Nahuatl, provided a theoretical lens for understanding how preservice teachers navigated between home and school knowledge systems (Anzaldúa, 1987). In our case, this space of in-betweenness became a productive site for recognizing the value of strategic knowledge in local households and creating new pedagogical approaches that honored both cultural wisdom and academic standards. Together, these frameworks supported our investigation of how cultural wisdom can serve as a foundation for meaningful STEM education.

Project Purpose and Design

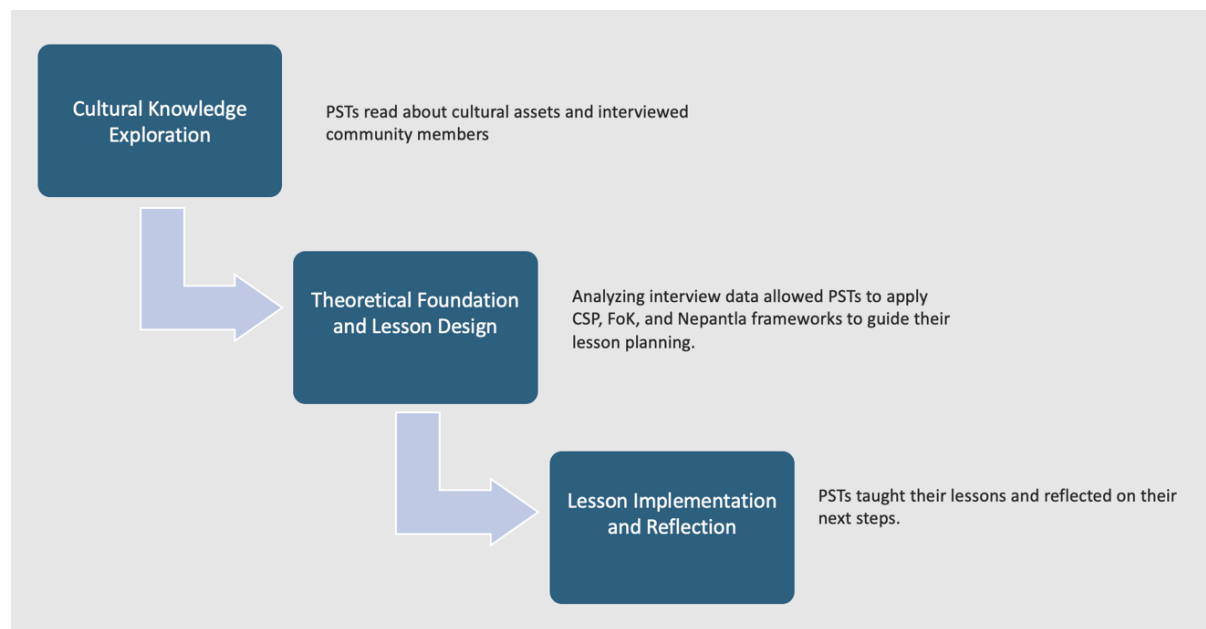
The purpose of this project was to understand how future Latina preservice science teachers (PSTs) used their cultural backgrounds and family knowledge to make STEM subjects more meaningful for their students. Our study took place during an elementary science methods course at a Hispanic-Serving Institution located near the U.S.-Mexico border.

Phases of the Lesson Planning Process

The lesson planning process began with cultural exploration during winter break and culminated in classroom implementation during the spring semester while they were enrolled in a science methods course. This multi-phase approach allowed PSTs to systematically integrate family and community knowledge into their pedagogical practices. Figure 1 below details an overview of this process.

Figure 1.

Phases of the Culturally Sustaining Lesson Planning Process



The Participants and the Context

We worked with three Latina PSTs from a group of nine enrolled in an elementary science methods course. Each represented a different teaching specialization: Estefania (a pseudonym) focused on early childhood through 6th grade with English as a Second Language, Josefina (a pseudonym) was an early childhood through 3rd grade with a Bilingual specialization, and Maria (a pseudonym) specialized in early childhood through 6th grade with a Special Education specialization. All three consented to participate and were teaching in elementary schools with mostly Latino/a students. All participants provided informed consent under Institutional Review Board (IRB) approval (IRB-24-0453).

The PSTs were teacher residents in a year-long or two-semester residency program in Fall 2024 and Spring 2025. The strategic staffing model adopted by the district was the co-teaching model, in which residents' only responsibility was to serve as co-teachers in their classrooms. In the Fall, teacher residents engaged in the field three days per week (Monday, Tuesday, Friday), and in the Spring, they engaged in the field four days per week (Monday, Tuesday, Thursday, Friday). The teacher residents' engagement consisted of planning and teaching lessons with their mentor teacher during the assigned days of the teacher residency program. This involved engaging with the district's curriculum to plan and implement lessons.

Phase 1: Cultural Knowledge Exploration (December 2024)

During winter break, preservice teachers conducted bilingual interviews with family and community members in two cities located along the U.S.-México border to uncover cultural stories, traditions, everyday practices, and local knowledge that could be connected to science concepts. These interviews established the cultural knowledge base for their pedagogical work.

The interview questions (see Appendix A) were designed by the authors and contained eight questions. The PSTs recorded and transcribed the interviews. Chapman et al. (2026) provide more details on how these interviews were conducted.

Phase 2: Theoretical Foundation and Lesson Design (Spring 2025, Weeks 1-8)

During weeks 1-4, the instructor introduced PSTs to CSP and FoK as theoretical foundations (Paris, 2012; Paris & Alim, 2017; Moll et al., 1992). The PSTs engaged in critical reflection, analyzing interview insights to identify cultural connections to STEM instruction and to highlight specific cultural wisdom they could leverage in teaching. They applied the CSP and FoK frameworks in selecting guiding concepts. PSTs presented ideas in class, led peer discussions, developed presentations about integrating cultural wisdom into science teaching, and participated in a STEM Education conference panel discussion.

During weeks 5-8, PSTs transitioned to active lesson design, brainstorming culturally sustaining lessons aligned to science content. They developed lessons aligned with the Texas Essential Knowledge and Skills (TEKS) that integrated bilingual literacy, mapping, sensory experiences, and mathematics and were grounded in cultural insights from family interviews. They adapted the lesson plan template from the Sheltered Instruction Observation Protocol (SIOP) framework (see Appendix B), which emphasizes integration of language and content objectives, explicit vocabulary instruction, and strategies making academic content comprehensible for multilingual learners (Echevarría, Vogt & Short, 2017). PSTs developed drafts, received peer feedback, refined lessons, and submitted final plans for implementation in teacher residency placements.

Phase 3: Lesson Implementation and Reflection (Weeks 9-16)

During weeks 9-15, the three PSTs implemented their lesson plans in their elementary field placement classrooms. The process concluded in week 16 with comprehensive reflection activities, including whole-group discussions and written reflections in which PSTs evaluated their experiences and articulated next steps in their professional development.

How the data were collected

Data were collected over six months (December 2024 to May 2025) in several ways. First, the PSTs conducted interviews with their family members about cultural knowledge, which were recorded and transcribed verbatim. Next, the 1st author collected and reviewed teaching materials and activities. Finally, the PSTs engaged in follow-up reflections in January 2025, which consisted of identifying areas for growth, improvement, and next steps. Specifically, the PSTs were asked to identify what went well and what they would do differently if they were to teach the lesson again. They were asked to reflect on how the interviews can be used to build relationships with parents by initiating collaborative efforts that enhance student learning and growth. Lastly, at the annual STEM education conference in February 2025, participants engaged in a panel presentation as panelists that provided further insights into their perspectives after their classroom implementation, and the panel presentation transcripts were reviewed and analyzed.

How sense was made of the data

The data analysis was guided by the following question: How do preservice teachers learn to center cultural wisdom in STEM lesson planning by drawing on students' cultural assets that reflect their home and community ways of knowing and doing? All authors analyzed the data by individually reading through all the interviews and materials multiple times to really understand what was happening, looking for important themes and ideas, both the expected and new, surprising ones. Each author developed codes individually, and the team met as a group to discuss the codes and reach consensus. This step was important to achieve intercoder agreement. The data were also triangulated using the interview transcripts, lesson plans, follow-up lesson reflections, and the STEM conference panel transcript. Finally, similar ideas were grouped and checked against the data to make sure they accurately represented what the PSTs experienced, paying special attention to how cultural knowledge from home became teaching strategies in the classroom.

Several strategies were used to ensure the trustworthiness of the findings. First, data were triangulated from the interviews, lesson plans, and conference transcripts. Second, the findings were shared with the PSTs to make sure the authors accurately understood their experiences. Lastly, detailed examples and context were provided so that other educators can decide whether the findings might apply to their own situations. This approach helped the authors to capture not just what these future teachers did, but how their cultural wisdom became powerful tools for STEM teaching.

Findings

Weaving Cultural Wisdom, Ancestral Knowledge, and Language into Science Learning

Our analysis revealed how PSTs successfully transformed home cultural practices into engaging science learning opportunities while valuing bilingual expression and preserving ancestral knowledge.

Josefina's Botanical Journey: Where Leaves Tell Family Stories

Josefina designed a standards-aligned lesson (Table 1) that engaged first-grade students as knowledge bearers, bringing leaves from home and sharing cultural stories (Figure 2). In addition, the students in Josefina's class were able to practice both basic (e.g., communication) and integrated (e.g., building graphs) inquiry skills, as well as science and engineering practices, including developing and using models, analyzing and interpreting data, and obtaining and communicating information. Students sought families' permission to bring leaves, honoring family authority and cultural protocols consistent with González et al.'s (2005) emphasis on respectful community engagement.

Table 1*Science Concepts and Standards*

PST	Science Concept	TEKS	NGSS
Josefina	Basic structures living organisms use to meet basic needs Asking questions based on observations Collecting observations and measurements as evidence Recording and organizing data Plants and animals have external structures that are crucial for their survival, growth, and meeting their needs	1A, 1E, 1F	NGSS 1-LS1-1
Estefania	Describe the cycling of matter and flow of energy through food webs, including the roles of the Sun, producers, consumers, and decomposers Differentiate between inherited and acquired physical traits of organisms Developing models of matter cycling among organisms in an ecosystem	12B, 13 B	NGSS 5-LS2-1, NGSS 5-LS1-2
Maria	Identify parts of plants such as roots, stems, and leaves. Use the five senses to explore properties of objects. Identify ways people use plants. Use observations to describe patterns of what plants and animals need to survive	5A, 6A, 10A	NGSS K-LS1-1

Students presented their leaves, explaining plant origins, household uses, and special memories. One brought *guayaba* (guava) leaves, sharing how her grandmother used them for tea to treat stomachaches. Another presented lime tree leaves used by their mother in making *limonada* (lemonade) and dishes like *caldo de pollo* (chicken soup). These narratives exemplify what Moll et al. (1992) describe as *strategic knowledge* that families accumulate through lived experiences (p. 139).

Figure 2

Introduction and Instruction: Lesson Segments of Josefina's Culturally Sustaining Lesson Plan

Introduction: (Time allocated: 5 min.) Okay, Ocelots! Today we are going to be scientists and mathematicians at the same time! We will explore something very special in our lives, the leaves that YOU brought from home. These leaves are from our nature and part of your family's stories, traditions, and the ways we take care of each other. In science, we are learning about what plants need to live and grow. In math, we are going to learn how to organize and count the different kinds of leaves you collected. By the end, we will see patterns (just like scientists do) and we will make graphs to share what we learned. Before we begin, I want to thank your families for helping you collect these leaves. When we bring something from home, remember that it's part of who we are. Today, your families' knowledge is part of our classroom learning. Next: (Hold up a leaf.)

Who did you talk to about your leaf? Did you ask your mom, dad, grandmother, or another family member? (In Spanish: ¿Con quién hablaste sobre tu hoja? ¿Le preguntaste a tu mamá, papá, abuelita u otra persona en tu familia?) We ask this question because science doesn't just come from the books we read. Science also comes from people and the knowledge they share. By telling us who you talked to, we are honoring our families as important teachers, too. (Call on 2–3 students to share. Allow answers in English or Spanish. Model how to respond using a sentence stem: "I talked to my..." / "Hablé con mi...") Thank you for sharing that. Now, let's look closely at our leaves and begin our investigation

Instruction: (Time allocated: 25 min.) Now that we've heard some of your family stories, let's look closely at our leaves. Scientists make careful observations. That means they look closely, they touch, they smell, and they describe what they notice.

In Spanish, observation is observación. We use our senses to describe things in detail.

When we describe, we can use these sentence starters: I notice that... / Yo noto que... or My leaf has... / Mi hoja tiene... Then show the bilingual sentence stem poster. Connect to an example shared in the introduction.

Model Classification: Show how to classify leaves by attributes: color, shape, size, texture, smell.

As you sort, say: My family used to grow lemon trees, so I know these leaves have a very strong smell. That is family knowledge helping me as a scientist.

Students Present: Invite 3–4 students to present their leaves.

Ask guiding questions: Where does this leaf come from? / ¿De dónde viene esta hoja? What does your family use it for? / ¿Para qué la usa tu familia? Does it remind you of a special time or place? / ¿Te recuerda un momento o lugar especial?

Connect responses to science: Example: So, your rosemary leaves are used in foods, that tells us that this plant is also part of your family's meals. So, we can see that plants give us food and flavor our meals.

Josefina guided students through collaborative data analysis, addressing NGSS Science and Engineering Practice 4 (NGSS Lead States, 2013). Specifically, students categorized leaves by attributes and created tally charts and bar graphs (Figure 3). She incorporated bilingual sentence stems such as "I notice that..." and "*Mi hoja tiene...*", reflecting García and Wei's (2014) translanguaging concept and the SIOP model (Echevarría, Vogt & Short, 2017). Josefina reflected on family connections to science: "My mom, she mentioned plants and gardening. I was thinking of a way that can be incorporated." [Josefina, STEM Education Conference Panel Reflection]. This aligns with EQuIP II.A.ii., as she engaged students in relevant and authentic scenarios that connected instruction to knowledge from home (Achieve, 2016).

When family members expressed themselves in Spanish during interviews, they shared sophisticated ecological knowledge. One mother described her nature connection:

Pues me gusta salir a caminar a los parques... Y con eso te conectas. Viendo las plantas y los árboles. (Well, I like to go for walks in parks... And with that, you connect. Seeing the plants and trees.) [Mrs. Coral (pseudonym), Interview conducted by Josefina]

This knowledge reflects what Cajete (2000) describes as Indigenous ways of knowing, directly informing Josefina's pedagogical approach and demonstrating how multilingual family interviews uncover rich scientific knowledge foundational to culturally grounded instruction.

Figure 3

Guided Practice, Independent Practice, and Closing Lesson Segments of Josefina's Culturally Sustaining Lesson Plan

Guided Practice: (Time allocated: 15 min) Now, in your groups, you will be leaf scientists. You will sort your leaves into categories based on their attributes. Remember, you can choose how to sort them: by color, size, shape, texture, or another characteristic you notice. As you work, think about what your family told you about your leaf. Does that knowledge tell you something about where the leaf belongs? For example, maybe your family said a leaf is used for cooking, and that might be connected to its smell or shape. (Distribute leaves, sorting cards, and tally chart templates.) Talk to your group using our sentence stems: I notice that.../ Yo noto que... and My leaf has... / Mi hoja tiene...
Independent Practice: (Time allocated: 15 min) Now, each of you will take your group's tally chart and make a bar graph. This is how scientists share their data. As you make your graph, think about your family story. Can you add a little note at the bottom to say who you talked to and what they told you? This way, our graphs will show what you learned.
Closing: (Time allocated: 10 min) Let's share what we discovered. Who can tell me one pattern they noticed in their graph? (Call on a few students and encourage bilingual responses.) Now, let's think about what we learned from our families that helped us in science today. Who can share something their family told them that connected to our investigation? (Students share stories and teacher writes a few on chart paper under the heading: Our Families as Scientists) Today we learned that science is not only found in the books or in our school it's also in our homes, our gardens, our kitchens, and our family traditions. By connecting what we know at home to what we learn at school, we become stronger scientists and mathematicians.

Estefania's Reimagining of Organisms and their Environments: Transforming Textbook Science into Living Knowledge

Estefania's work exemplifies how PSTs can critically examine and adapt existing district curricula to be more culturally sustaining while maintaining alignment with standards (Table 1). She adapted instructional materials that embedded students' lived experiences into an 'organisms and their environments' unit (Figures 4 and 5), noting that the textbook provided visuals featuring generic landscapes. She invited students to bring meaningful family photos of backyards, gardens, ranches, or parks. The district curriculum emphasized following the

learning sequence for organisms and their environments. While the lesson focused on producers, consumers, and decomposers (TEKS 4.12.B), it also reinforced previous learning on genetics, where the students learned about inherited and learned traits (TEKS 4.13.B).

Figure 4

Introduction and Instruction: Lesson Segments of Estefania's Culturally Sustaining Lesson Plan

Introduction: (Time allocated: 5 minutes) Today we're going to explore how life works in the places that matter most to us like our homes, gardens, farms, ranches, and parks. You've brought in photos from your family, places that are special to you, and we're going to use them to understand ecosystems and traits. Before we start, let's thank our families for helping us find these photos. When we bring something from home, we're also bringing part of our story into the classroom. That story is just as important as the science we learn from books. Now, let's connect to what we've already learned. Remember when we talked about producers, consumers, and decomposers? Producers are plants that make their own food, consumers are animals that eat plants or other animals, and decomposers are organisms that break down waste and return nutrients to the soil. Today, you're going to look for examples of these in your own photos. We've also been learning about inherited traits, which are things an organism is born with, like the shape of a leaf or the color of an animal's fur and learned behaviors, which are things that are taught or learned through experience, like a family recipe for planting seeds or training a dog to herd sheep. As we work with our photos today, I want you to think about both: What traits are inherited, and what behaviors are learned in the places you know best? Today, instead of looking at pictures from a textbook, today we will use YOUR photos so that the examples are from places you know and love. Who can tell me what's in their photo? In Spanish, we might say: ¿Qué hay en tu foto? Maybe you see a tree, some plants, or even animals. Let's share a few examples before we begin our investigation. Students share out their examples. Call on several students to share examples. Encourage bilingual responses and connect their answers to the concepts. Example: That mango tree is a producer or Learning to plant corn with your grandfather is a learned behavior.

Instruction: (Time allocated: 25 minutes) Okay now we will transition to explore and learn more about today's topic.

Modeling: Here's a photo of my grandmother's backyard. I see chile plants (producers), a dog (consumer), and a compost pile (decomposers). Highlight traits: The chile plant has small, pointy leaves, that's an inherited trait. My grandmother taught me when to water the plants, that's a learned behavior. Review vocabulary in English and Spanish: Producer Productor, Consumer Consumidor, Decomposer Descomponedor, Inherited Trait Característica heredada, Learned Behavior Comportamiento aprendido

Think about what your family has taught you about caring for plants or animals. Those are learned behaviors, and they're part of science too. Turn to your partner and discuss. Have students share out.

Figure 5

Guided Practice, Independent Practice, and Closing Lesson Segments of Estefania's Culturally Sustaining Lesson Plan

Guided Practice: (Time allocated: 15 minutes) Students work in small groups, each group sharing their photos and identifying producers, consumers, and decomposers, plus one inherited trait and one learned behavior.

Encourage them to discuss what they know about each element from family experiences.

Example: My dad says the mesquite tree gives good shade and helps the soil stay cool. Mi papá dice que el mezquite da buena sombra y ayuda a que la tierra se mantenga fresca.

Provide classification cards with color-coded labels for *producers*, *consumers*, and *decomposers*.

Independent Practice: (Time allocated: 15 minutes)

Students create a simple labeled diagram or mini-model of the ecosystem shown in their photo, showing the connections between producers, consumers, and decomposers.

For inherited and learned traits: Ask: Can you think of a plant or animal in your photo that has a trait it inherited? Puedes pensar en una planta o animal en tu foto que tenga una característica que heredó? What is something you learned from a family member about taking care of plants or animals? Qué aprendiste de un miembro de tu familia sobre cuidar plantas o animales?

Students write one sentence for each using the stems: An inherited trait is... Una característica heredada es... and A learned behavior is... Un comportamiento aprendido es...

Closing: (Time allocated: 10 minutes) Invite students to share their diagrams and one cultural connection they made. Call on a few students to share in English or Spanish.

Wrap up: Today, we saw that ecosystems aren't just something we read about. We learned that they are part of our daily lives. And the knowledge our families share helps us understand science a deeper way.

Estefania used her students' photos to identify producers, consumers, and decomposers in familiar ecological settings. When teaching about inherited and learned traits, she drew connections to students' family stories. Students shared traditions related to farming, cooking, or outdoor work, sparking discussions about learned behaviors and inherited traits. One student described how their grandfather taught them to plant and harvest corn on the *rancho* (ranch), noting this was a skill learned through observation. This illustrates what Windschitl (2006) describes as the "hidden funds of knowledge about all kinds of natural phenomena" that students possess but teachers often fail to recognize (p. 355).

Estefania's insights demonstrate an asset-based approach that recognizes cultural knowledge as intellectual resources (Yosso, 2005). During family interviews that informed her

lesson design, she learned about the importance families place on preserving cultural knowledge across generations, reflecting what Delgado-Gaitan (2001) describes as educational functions that families serve in maintaining cultural continuity.

During the interview phase, the mother expressed her commitment to cultural continuity:

Para que cuando mis propios hijos hagan sus propias familias, también lleven esa tradición a su casa... Porque son ancestrales. Tradiciones ancestrales de muchos años. (So that when my own children start their own families, they also carry those traditions into their homes... Because they are ancestral. Ancestral traditions of many years.) [Mrs. Lucia (pseudonym), Interview conducted by Estefania]

This reflects what Tuhiwai Smith (2012) describes as Indigenous conceptualizations of knowledge as inherited responsibility. Estefania incorporated this understanding by positioning students as carriers of important ecological knowledge from their families. She reflected on the cultural integration timing, centering it as part of her practice:

Integrating culture into our lessons is right now for us... It's the best moment, because if we start our careers integrating culture, it will come naturally to us in 5 or 10 years. [Estefania, STEM Ed Conference Panel Reflection]

Maria's Sensory Garden: Bridging Home Knowledge and Special Education Science

Maria's lesson, designed for early childhood special education and aligned with the standards (Table 1), exemplifies how CSP can be inclusive and accessible across diverse learning needs while honoring students' cultural wisdom (Figures 6 and 7). Her approach centered on students' sensory experiences and home-based knowledge of plants, addressing both the diverse learning styles required in special education settings and the cultural assets that students bring from their families. Children smelled plants used in cooking, such as *epazote* (Mexican tea), mint, and rosemary, and used their senses to explore the plants through touch, sight, and smell, incorporating what González et al. (2005) describe as the household knowledge that students bring from home as part of scientific inquiry.

Figure 6

Introduction, Instruction, and Guided Practice: Lesson Segments of Maria's Culturally Sustaining Lesson Plan

Introduction: (Time allocated: 8 minutes) Begin with a soft chime and greet students with our morning affirmation circle. "I am smart. I am beautiful. And today is going to be a great day today!" Students click on the Newline to express how they feel using visuals like happy, sleepy, excited. Then they look out the window and check the weather together and share what. They observe. Say: "Today we will learn about the plants we use to cook. They can have a smell and they can feel bumpy or soft" Show the students the plants and go around letting each student touch the plant. Raise your hand if you have seen it at home. Let students share. What do you use it for?

Instruction: (Time allocated: 30 minutes) Introduce each plant epazote, mint, and rosemary and model for students what observations they can make and how to handle the plants gently and with respect. On the newline use Boom cards to have students come up and identify the parts of a plant like leaf/hoja, stem/tallo, and root/raíz. Show a bundle of rosemary and pass it around the circle. Say what do you see? It is round and pointy and smells strong! Say it in Spanish. Huele muy fuerte y es la hoja. Say that in my family we use rosemary to make caldo. This reminds me of my grandma's house. Ask students to touch and smell each plant as a group and describe what they notice using sentence stems: I feel... Yo siento.... I smell.... Yo huelo... and It looks like... Se mira como...

Guided Practice: (Time allocated: 20 minutes)

Students do a sensory station rotation.

Station 1: Touch and Sort Station. Students use texture cards smooth, rough, soft, and pointy to sort leaves.

Station 2: Smell and Match. Students smell herbs in covered herb jars and match them to the real leaves. Ask students: "Which ones have you smelled at home?"

Station 3: Parts of the Plant Puzzle: Using laminated sheets, students place leaf, stem, and root in the correct position on a plant diagram .

As students work, I will move between stations to help students and so will the teacher assistants.

Figure 7*Independent Practice and Closing Lesson Segments of Maria's Culturally Sustaining Lesson Plan***Independent Practice: (Time allocated: 15 minutes)**

Students draw or use pre-cut shapes to make their own drawing of the plant.

They glue the plant visual onto their paper and label the plant visual with support. They will use sentence stems to write: I felt a leaf . It was _____. Senti una hoja y era _____ and My family uses this leaf for _____. Mi familia usa esta hoja para _____. For early finishers, they will create art leaf rubbings.

Closing: (Time allocated: 10 minutes)

We come back together to the carpet as a circle and share the drawings. Students share one thing they noticed. Students also share how their family uses the plant. They also share what they love about the plant.

This sensory-rich approach reflects what Moll et al. (1992) identify as FoK—the accumulated wisdom about plant uses and properties that families possess and transmit through everyday practices like cooking and home remedies. By inviting students to draw upon their familiarity with these plants from their home kitchens and family gardens, Maria positioned students as experts who could contribute meaningful knowledge to classroom learning. She guided students in identifying plant parts, using their senses to explore properties, and understanding how people use plants, thus connecting students' lived experiences with formal scientific concepts.

Maria's work demonstrates how CSP (Paris & Alim, 2017) can be adapted for students with diverse learning needs, showing that cultural sustainability and inclusive education are not competing approaches but rather complementary frameworks that can enhance learning for all students. Her lesson illustrates movement through *nepantla* or creating spaces where students' home knowledge about plants and their sensory exploration abilities become valuable resources for scientific understanding, rather than obstacles to overcome (Anzaldúa, 1987).

Josefina and Maria's Honoring Plant Medicine and Ecological Knowledge

Participants uncovered rich traditional knowledge about plants and their medicinal uses through family interviews, revealing what Berkes (2012) terms traditional ecological knowledge—a sophisticated understanding of local environments developed over generations of observation and experimentation. This knowledge directly aligns with TEKS and NGSS standards related to plant structures and functions, and to the relationship between plants and their environment (NGSS Lead States, 2013; Texas Education Agency, 2022).

Josefina shared insights from conversations with her mother about traditional plant knowledge: “She mentioned laurel/bay leaf and different plants that she grew up with...You don't really see here, or maybe it's not as common here, but she would make teas, and she would make medicine like she would use [for] medicinal purposes.” [Josefina, STEM Education Conference Panel Reflection]. Josefina’s reflection reveals her recognition of the botanical and pharmacological knowledge embedded in her mother's practices. This knowledge represents what Moll et al. (1992) describe as Funds of Knowledge. She continued, describing how these Funds of Knowledge could inform teaching: “My mom says she grew up with, and that's like, she had teas and used them for medicine and all that kind of stuff. So, I was like, Oh, that's a good thing to integrate science!” [Josefina, STEM Ed Conference Panel Reflection]. Josefina’s “aha moment” demonstrates her movement through *nepantla*—the recognition that her mother's knowledge is not separate from science but rather represents a different, culturally sustaining way of engaging with scientific phenomena. This realization was made possible through bilingual family interviews that allowed for deeper exploration of ecological knowledge than would have been possible in English-only interactions, supporting García and Wei's (2014) research on translanguaging as a resource for uncovering community knowledge systems.

Similarly, Maria's work also honors traditional plant medicine and ecological knowledge by recognizing that the plants familiar to her students—*epazote*, mint, and rosemary—represent what Berkes (2012) describes as traditional ecological knowledge systems embedded in family cooking and healing practices. Her pedagogical approach demonstrates movement through *nepantla*, creating inclusive spaces. This approach also reflects García and Wei's (2014) concept of translanguaging, where students' multilingual and multicultural knowledge about plant properties enhances rather than hinders their scientific learning, showing how traditional ecological knowledge can be made accessible across diverse learning abilities, including special education students, while maintaining its cultural authenticity and scientific validity.

Discussion

Our findings demonstrate how cultural wisdom can serve as a powerful foundation for STEM education, particularly in border communities where students navigate multiple cultural and linguistic worlds. Through our theoretical lens combining CSP, FoK, and *nepantla*, we identified three key implications for science teacher education: (a) repositioning cultural knowledge as scientific capital, (b) developing culturally sustaining STEM pedagogies, and (c) fostering critical consciousness in teacher preparation.

Repositioning Cultural Knowledge as Scientific Capital

Our project demonstrates that family traditions, practices, and wisdom systems are sophisticated forms of scientific understanding—what we conceptualize as *scientific capital* embedded in cultural practices. Building on Bourdieu (1986), we delineate discrete scientific capital as a form of cultural capital to show how families' scientific knowledge can enhance academic learning when recognized in educational settings. When PSTs valued this knowledge, they developed asset-based approaches aligned with Paris and Alim's (2017) culturally sustaining pedagogy. Lessons like Josefina's leaf investigation illustrate how cultural practices serve as authentic contexts for scientific inquiry: students began with familiar plants and family

knowledge, then built toward scientific understanding through observation and analysis. This reflects movement through *nepantla*—productive spaces where knowledge systems coexist (Anzaldúa, 1987).

Developing Culturally Sustaining STEM Pedagogies

Josefina, Estefania, and Maria developed pedagogies that honor cultural authenticity and academic rigor, reflecting *third space* pedagogy (Moje et al., 2001). They adapted curricula, designed culturally grounded assessments, and facilitated bilingual learning. Family interviews proved transformative, aligning with González et al. (2005) in their ethnographic approach to funds of knowledge. When families expressed themselves in Spanish, they shared nuanced understandings that might have been lost in English-only contexts. As Estefania emphasized: "I really think that we need to connect with the families" [Estefania, STEM Ed Conference Panel Reflection]. This bilingual engagement supports García and Wei's (2014) research on translanguaging as a resource for learning.

Fostering Critical Consciousness in Teacher Preparation

Beyond pedagogy, PSTs critically examined inequities. They questioned whose knowledge is valued, challenging hierarchies, privileging textbooks over lived, generational wisdom. Recognizing how curricula often marginalize community knowledge, they began positioning themselves as facilitators of learning in which students' knowledge systems and academic excellence are synergistic. This reorientation fostered richer, more relevant, and more equitable STEM learning experiences.

Implications for Practice

The purpose of the project was to have Latina PSTs use their cultural backgrounds and family knowledge to make STEM subjects more meaningful for their students by honoring students' knowledge assets from home. These are ideas that have been extensively studied by Moll et al. (1992) and Anzaldúa (1987), and they support the practice of valuing students' assets in science classrooms. Based on our findings, we offer several recommendations for science teacher educators: (a) start with cultural exploration by engaging PSTs in deep exploration of their own cultural knowledge and that of their students' communities; (b) use authentic assessment that values cultural integration by moving beyond traditional lesson planning to help PSTs identify, honor, and build upon students' cultural assets; (c) provide ongoing support through learning communities where PSTs can share challenges and continue growing in their practice. This approach aligns with recent research on Professional Learning Communities (PLCs) that emphasizes collaboration in developing sociocultural teaching practices (Chiang et al., 2024); (d) center family voices as co-educators by ensuring that cultural integration efforts are guided by families and communities rather than educators' assumptions, reflecting Moll et al.'s (1992) emphasis on reciprocal relationships between schools and communities. Through this collective work, students are encouraged to pose and answer their own questions, circumscribed to their own realities and ways of being, extending that exploration into the worlds of science to bridge school science and their conceptualizations of the natural world at

home, in the garden, where they develop knowledge and skills to become learners who "can access and make sense of science relevant to their lives" (Feinstein, 2011, p. 314).

Conclusion

This project demonstrates the transformative potential of centering cultural wisdom in STEM teacher education. When PSTs learned to see family knowledge as scientific capital, they developed more inclusive and effective pedagogical approaches. As our participants noted, integrating culture into teaching from the beginning of their careers will *help it come naturally over time*, shifting it from an add-on to a foundational practice. This suggests that teacher preparation programs play a crucial role in establishing foundations for culturally sustaining pedagogies that are both academically rigorous and deeply meaningful to students' lives. The implications extend beyond individual classrooms to broader STEM equity and teacher education policy. Programs that systematically integrate culturally sustaining practices into methods courses, paired with sustained fieldwork and mentorship, equip new teachers with confidence and skill to teach STEM in ways that are inclusive, standards-aligned, and culturally sustaining. In the context of persistent opportunity gaps in STEM, this approach represents a strategic lever for equity by diversifying pathways for historically marginalized students and ensuring that knowledge systems of students' communities are valued as legitimate sources of learning.

References

- Achieve. (2016). EQuIP rubric for lessons & units: Science. Achieve. <https://www.achieve.org>
- Anzaldúa, G. (1987). *Borderlands/La frontera: The new mestiza*. Aunt Lute Books.
- Barton, A. C. (2003). *Teaching science for social justice*. Teachers College Press.
- Barton, A. C., & Yang, K. (2000). The culture of power and science education: Learning from Miguel. *Journal of Research in Science Teaching*, 37(8), 871-889. [https://doi.org/10.1002/1098-2736\(200010\)37:8<871::AID-TEA7>3.0.CO;2-9](https://doi.org/10.1002/1098-2736(200010)37:8<871::AID-TEA7>3.0.CO;2-9)
- Berkes, F. (2012). *Sacred ecology*. Routledge.
- Bourdieu, P. (1986). The forms of capital. In J.G. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241-258). Greenwood. <https://jan.ucc.nau.edu/~sj6/Bourdieu,%20The%20Forms%20of%20Capital.pdf>
- Cajete, G. (2000). *Native science: Natural laws of interdependence*. Clear Light Publishers.
- Chapman, A. M., Ward, H. C., Tiwari, A., Weimer, A., Duran, J. B., Guerra, F., & Sale, P. (2017). The role of language in anatomy and physiology instruction. *The American Biology Teacher*, 79(3), 184-190. <https://doi.org/10.1525/abt.2017.79.3.184>
- Chapman, A., & McHatton, P. A. (2022). It helps to know Spanish: A multicultural approach by tapping into Latinx learners' native language to learn science. In *International Handbook of research on multicultural science education* (pp. 653-682). Cham: Springer International Publishing.
- Chapman, A., Weimer, A. A., Torres-Avila, M., Trejo, C., & Racelis, A. (2022). The effects of teaching undergraduate freshmen biology courses in Spanish and English. *SN Social Sciences*, 2(11), 248. <https://doi.org/10.1007/s43545-022-00551-0>
- Chapman, A., Medina-Jerez, W., Schall, J. M., Ganesan, U., Lynch-Arroyo, R., Ortiz, M., & Tschoshanov, M. (2026). A (n)(re) awakening: preservice teachers connecting their culture to science teaching along the US–México border. *Cultural Studies of Science Education*, 1-29. <https://doi.org/10.1007/s11422-026-10282-w>
- Chiang, K. M., Yin, H., Lee, I., & Chang, C. H. (2024). Taking stock of the research into professional learning communities: Paradigms, pathways, and possibilities. *Teaching and Teacher Education*, 139, 104431. <https://doi.org/10.1016/j.tate.2023.104431>
- Delgado-Gaitan, C. (2001). *The power of community: Mobilizing for family and schooling*. Bloomsbury Publishing PLC.
- Echevarría, J., Vogt, M., & Short, D. J. (2017). *Making content comprehensible for English learners: The SIOP model* (5th ed.). Pearson.

CULTURAL STEM WISDOM FOR LESSON PLANNING

- Feinstein, N. (2011). Salvaging science literacy. *Science Education*, 95(1), 168-185.
<https://doi.org/10.1002/sce.20414>
- García, O., & Wei, L. (2014). *Translanguaging: Language, bilingualism and education*. Palgrave Macmillan.
- González, N., Moll, L. C., & Amanti, C. (Eds.). (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Lawrence Erlbaum Associates.
- Heineke, A.J., & McTighe, J. (2019). Science units of study with a language lens: Preparing teachers for diverse classrooms. *Innovations in Science Teacher Education*, 4(3).
<https://innovations.theaste.org/science-units-of-study-with-a-language-lens-preparing-teachers-for-diverse-classrooms/>.
- Medina-Jerez, W., & Dura, L. (2020). Food pedagogy as an instructional resource in a science methods course. *Innovations in Science Teacher Education*, 5(3).
<https://innovations.theaste.org/index.php/iste/article/view/334>
- Moje, E. B., Ciechanowski, K. M., Kramer, K., Ellis, L., Carrillo, R., & Collazo, T. (2001). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, 39(1), 38-70.
<https://doi.org/10.1598/RRQ.39.1.4>
- Moll, L., Amanti, C., Neff, D., & González, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice*, 31(2), 132-141. <https://doi.org/10.1080/00405849209543534>
- NGSS Lead States. (2013). *Next generation science standards: For states, by states*. National Academies Press. <https://www.nationalacademies.org/read/18290/chapter/1#ii>
- Ortiz, M. M. (2024). *They See Themselves in the Lesson: Leveraging students' Scientific and Cultural Insights Through the Cultural Biohealth Synergy Science Curriculum* (Doctoral dissertation, The University of Texas Rio Grande Valley).
<https://scholarworks.utrgv.edu/etd/1569/>
- Paris, D., & Alim, H. S. (Eds.). (2017). *Culturally sustaining pedagogies: Teaching and learning for justice in a changing world*. Teachers College Press.
- St. Clair, T., & McNulty, K. (2021). From theory to practice: Funds of knowledge as a framework for science teaching and learning. *Innovations in Science Teacher Education*, 6(2).
<https://innovations.theaste.org/from-theory-to-practice-funds-of-knowledge-as-a-framework-for-science-teaching-and-learning/>
- Texas Education Agency. (2022). *Texas essential knowledge and skills for science: Subchapter A. Elementary*. Retrieved from <https://tea.texas.gov>

CULTURAL STEM WISDOM FOR LESSON PLANNING

Tuhiwai Smith, L. (2012). *Decolonizing methodologies: Research and indigenous peoples* (2nd Edition). Zed Books.

Valdés, G. (1996). *Con respeto: Bridging the distances between culturally diverse families and schools: An ethnographic portrait*. Teachers College Press.

Windschitl, M. (2006). Why we can't talk to one another about science education reform? *Phi Delta Kappan*, 87(5), 349-355. <https://doi.org/10.1177/003172170608700505>

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, 8(1), 69-91.
<https://doi.org/10.1080/1361332052000341006>

Appendix A: Interview Questions

Question	Possible follow-up questions
1. Can you tell us about some of the activities you like to do at home? Outside?	1a. Who do you typically do these activities with? 1b. In your daily life, are there activities that you or a family member do regularly and/or together (example: cooking, building, gardening)?
2. What traditions or activities do you engage in that connect you with nature or the environment?	2a. Are there particular seasons, plants, or animals that hold special significance in your culture? If so, what is their significance? 2b. Can you describe one traditional activity you were/are responsible for in your family?
3. Can you describe one traditional activity you were/are responsible for in your family?	3a. When were you assigned this chore/responsibility? 3b. Who used to be responsible for this chore/activity? 3c. How did you become responsible for this chore/activity?
4. Tell us about a favorite holiday or celebration in your family.	4a. How do these activities help you stay connected to your family? 4b. Who currently organizes this holiday/celebration? 4c. Who organized the holiday/celebration previously? 4d. Why does your family continue the tradition?
5. Tell me about a story or saying/ <i>dicho</i> that you learned from an elder?	5a. How did that story or saying/ <i>dicho</i> make you feel or impact your life?
6. What is the importance of language in passing down knowledge in your family or community?	6a. When you were a K-12 student, what languages did you use at home? School? Community? 6b. Why did you use those languages in each setting? 6c. Are you worried about future generations (children, nieces, nephews...) will lose the heritage language and family traditions?
7. Are there any practices or knowledge from your culture that you feel are being lost or no longer being practiced as they once were?	7a. For example, are there things your grandparents or older generations practiced that you wish were more valued or continued by younger generations, especially since moving to a new place or adapting to new ways of life? If so, why? 7b. What are some obstacles that contribute to why these traditions are being lost? 7c. How does technology contribute to these traditions being lost?
8. How comfortable are you expressing your family culture and traditions?	8a. At home? 8b. In the community, such as a place of worship, grocery store, bank, city park? 8c. How has this influenced your identity or who you are?

Appendix B: Lesson Plan Template

LESSON PLAN TEMPLATE

TEACHER RESIDENCY

Resident Name:	Semester & Year:
Formal Observation Number:	School Campus:
Topic:	Date & Time:
Grade:	Duration:
Standards: TEKS: ELPS: NGSS:	
Objectives: •	
Materials:	
Technology:	
Introduction: (Time allocated:)	
Instruction:(Time allocated:)	

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Guided Practice:(Time allocated:)
Independent Practice: (Time allocated:)
Closing:(Time allocated:)
Assessment:(Time allocated:)

SLOP features+

In one lesson, it is not possible to integrate all the features of SLOP. Identify and do the things that will help the students understand the specific learning objectives during their activities. Double-click the gray box to add a check to what features you have included in the lesson plan.

Preparation ☐ Adapt content to proficiency level ☐ Link to background (family / community) ☐ Links to home language ☐ Links to prior learning	Strategies for Students ☐ Predict ☐ Summarize ☐ Categorize ☐ Evaluate ☐ Solve problems ☐ Self-monitoring ☐ Other(s):	Scaffolding ☐ Pattern / model ☐ Guided practice ☐ Practice alone ☐ Comprehensible input ☐ Demonstrations ☐ Visuals ☐ Graphic organizer
Grouping ☐ Whole class ☐ Small groups ☐ Pairs		
Higher-Order Thinking ☐ Compare ☐ Deconstruct ☐ Evaluate ☐ Formulate hypotheses ☐ Plan ☐ Experiment ☐ Design ☐ Build ☐ Other(s):	Language domains/processes ☐ Read ☐ Write ☐ Speak ☐ Listen	Review ☐ Review vocabulary ☐ Review key concept ☐ Supply feedback
	Application ☐ Hands-on activity ☐ Useful and relevant ☐ Links to objectives ☐ Promote participation	Assessment ☐ Individual ☐ Group ☐ Written ☐ Oral