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Escúchame, Mi Ciencia Cuenta: Leveraging Cultural Ways of Knowing to Increase Chicana STEM Engagement

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ESCÚCHAME, MI CIENCIA CUENTA: LEVERAGING CULTURAL WAYS OF KNOWING TO INCREASE CHICANA STEM ENGAGEMENT

A Dissertation

by

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ABSTRACT

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This paper is about leveraging cultural ways of knowing such as ethnobotany in order to increase STEM engagement in Chicanx populations. The novel Community Learning and Ecological Sustainability Paradigm (CLESP) framework utilized in this study combines social justice, Chicana feminist epistemology, land-based pedagogy, critical place-based pedagogy, pedagogical praxis, pluralism and ecological sustainability to achieve this end. Four preservice Chicana science teachers provided testimonio from their elder assignment and engaged in two focus groups in order to identify relevant themes that impact Chicana engagement in STEM. Major themes identified were challenges in bilingual education, elder knowledge as a form of pedagogy, stagnation in common science teaching practices, tensions between lived experiences and traditional science teaching, and leveraging community support. We advocate for a paradigm shift in science teacher preparation that must include cultural factors to promote Chicanx connection with STEM content.

DEDICATION

Alex (Evie), words cannot even begin to express how grateful I am for your unwavering support and dedication throughout this whole journey. Know that you are my rock, the love of my life and I couldn't have done this without you. I love you.

To my children Tristan, Tyler, and Nolan; thank you for your patience and sacrifice. I know you sacrificed so much time away from me. Know that this is yours as much as it is mine. I love you all so much.

To my parents whom I love dearly, thank you for always encouraging me and for believing in me. As a rebellious child I know you all did not have it easy. Thank you for teaching me how to channel that rebellion into fighting for what I believe in.

Family and friends, thank you for listening to me, giving me words of encouragement, and cheering for me along the way.

To my participants in this study, know that you are seen and heard. I hope you continue to advocate for change in science education, your voice matters.

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CHAPTER I

INTRODUCTION

> The struggle is inner: Chicano, Indio, American Indian, Mojado, Mexicano, immigrant Latino, Anglo in power, working class Anglo, Black, Asian — our psyches resemble the border towns and are populated by the same people. The struggle has always been inner, and is played out in outer terrains. Awareness of our situation must come before inner changes, which in turn come before changes in society. Nothing happens in the "real" world unless it first happens in the images in our heads. (Anzaldúa, 1987, pp. 87)

The epigraph above eloquently articulated Anzuldua's notion of awareness of moving "towards a new critical consciousness." The need for critical consciousness and teacher praxis within science education is dire and it must begin with the Chicana's understanding of their own culture, teacher identity, and critical consciousness. To this end, I ask: What are the testimonios of Chicana preservice teachers and how does this inform their understanding of critical approaches in science education in early childhood classrooms? This question shapes my critical inquiry as I begin to explore how elementary Chicana preservice teachers in the Rio Grande Valley region leverage their own lived experiences in cultural indigenous ways of knowing into their own teaching practice. As a Chicana native to the Rio Grande Valley, my own testimonio

drives this inquiry, with specific focus on how I experienced the teaching of science in my early educational years. Also included are testimonios from other preservice elementary teachers in the region.

Starting from the Roots

My great-grandmother once said you cannot understand the growth of the tree without understanding the seed and the durability of the roots. My roots stem from a maternal lineage of ecofeminism and ethnobotany. Ecofeminism may be broadly understood as a "critical approach to counteract the hegemonic discourses, [where] the conditions emerge to awaken [women's] interests in the defense of nature and other living beings" (Puleo, 2017, p. 27). In my family, ecofeminism is intricately woven with the tradition of ethnobotany: women were the caretakers and healers of our families, their traditional knowledge having been passed down through the ages. I will elaborate more about my roots by sharing my own testimonio to paint an intimate portrait of my life as well as my struggles as a Chicana in the Rio Grande Valley.

My love for nature and science began at an early age. I was born to be a scientist. As a little girl, I was always told that I was "traviesa" – mischievous. At 5 years old, I remember mixing Ajax with bleach, causing everyone to run out of the house because of the smell. Although we were very poor, I never felt poor, just different. After all, who needs TV when every day I would spend hours finding bugs, playing in dirt, sorting and collecting rocks, climbing trees, sketching bugs on torn up paper bags from the grocery store. My grandmother's backyard was my wonderland. The smell of jasmine and orange blossoms wafting through the air, the tartness of fresh oranges on my lips while the cicadas sang songs of another world. My world was rich with experiences.

My ecofeminism can be traced here as well: my roots are entwined with the freedom of exploring nature and understanding the reciprocal relationship with care of nature and the land. I fondly recall that my great-grandma would show me what local plants I can use to make “Te de Naranja” (Orange Teas) or other teas as remedies for different illnesses. I remember asking her where she learned this from and she whispered, “Es un secreto, pero un día te diré” (“One day I will tell you”). As I grew up and she grew feebler, she would make me gather her herbs and tell me how to prepare them for her. It was at that moment I realized that she trusted me with her “secrets”. These secrets also came with the responsibility of maintaining the relationship of reciprocity between myself and the plants. My great-grandmother was very meticulous about her plant care. They were almost like her children in that she cared for them daily and she would scowl at me if I dared to overwater them or move them. Everything in that garden had a purpose and a place. These plants were special not only to her but to the small community around her. These plants were a part of the remedios caseros that our small community of neighbors, family and friends used as medicine. My great-grandmother was considered a healer in our small community. Many people could not afford to go to the doctor or have regular healthcare, so she took on this role as the community healer. She used different herbs for migraines, stomach aches, sore muscles or limpias de susto.

> “Susto" is loosely translated, "fright,” but it's deeper meaning is “soul loss” or “soul sickness.” Symptoms might include stomach pain, loss of appetite, lethargy, anxiousness, or a feeling that something is missing—that you are not fully present in your own body. (Seman, 2021, p. 14)

I often marveled in awe at my great-grandmother's abilities to console others and help people in need. My great-grandmother was from a long line of healers. She was from a small village near Guanajuato. She learned the art of ethnobotany from her family as it was passed down from one generation to the next, oral tradition being all that survived the destruction of foreigner invaders that ravaged the land from the indigenous people in her pueblito. I always wanted to know more about where she came from but behind her stern voice was a sense of pain that her eyes would clearly tell. The times that she did speak of her past she often spoke with a melancholic tone as she would begin to describe "los Indios de mi tempo" but her stories would always end abruptly as her voice would trail off and she would just turn away. Even as a small girl, I knew when to stop asking questions about her past and slowly I just learned to stop asking all together.

My bisabuelita did not have a formal science education. Thus, her botanical knowledge of the plant's healing properties came along with a negative connotation in Mexican culture — she was commonly known as a curandera (a witch doctor). Since there was prominent xenophobia and racial prejudice in Texas, she kept her knowledge about ethnobotany a secret to outsiders. The fear of this xenophobia was instilled in all of us. She was firm about keeping her "secrets. She would say, "Sshh…"En bocas cerradas, no entran las moscas". This dicho or adage meant that even though we practiced remedios caseros at home, you were not supposed to talk about it at school. In fact, talking about our home life to outsiders was frowned upon and met with a stern lecture or punishment.

Although we were told to keep quiet about our "secrets", the landscape of the Rio Grande Valley (RGV) is visibly shrouded in them. You can walk anywhere in the downtown areas in the

RGV and see Yerberias and Botánicas. In fact, Yerberias and Botánicas are just as plentiful as grocery stores, and they are easily found all over the RGV.

Historical Context of Ethnobotany in the RGV

In the previous paragraphs I described how ethnobotany, history of the land and the love of nature was instilled in me through my lived childhood experiences. In this section, I will describe how my experience with ethnobotany is not an insular experience but rather a collective cultural experience shared by the RGV community.

To understand the collective experience shared by the community in the RGV, I must first share the historical context of ethnobotany, providing some key terms that define this practice through a social cultural lens. This historical context is necessary since it provides the underlying foundation to connecting "science" or indigenous ways of knowing to the cultural aspects of the community in my inquiry. I begin by providing an overview of ethnobotany and its regional implications.

Ethnobotany is considered the study of plants and their uses through traditional knowledge of a region or culture (Jain, 2010). In the RGV, ethnobotany is referred to as folk medicine, remedios caseros or curanderismo. "The word curanderismo comes from the Spanish verb curar, meaning "to cure" or "to heal." (Seman, 2021, p. 2). According to (Seman, 2021) curanderismo is a culmination of practices "Old" and "New" worlds that encompass "folk" medical practices, indigenous beliefs, and Catholic rituals. Although curanderismo has existed for centuries, one of the first historical accounts of curanderismo in the borderlands dates to 1528 to 1536. This is accounted for by the report of:

> Álvar Núñez Cabeza de Vaca, a Spaniard who, along with three others, survived a failed expedition of New World conquest and

> spent six years in captivity among various Native people along the Texas-Mexico borderlands. He survived his captivity, in part, by becoming a curandero. Cabeza de Vaca wrote a relación (report) providing an account of this failed conquest and period of captivity. In it he describes how he and his fellow survivors—two Spaniards and one enslaved African—traveled by foot as captives across a region that today we call the US-Mexico borderlands. (Seman, 2021, p. 10).

In addition to the evidence of curanderismo in De Vaca's report, other Borderland Curanderios such as Teresa Urrea and Don Pedrito Jaramillo have "been the subject of scholarship produced in Mexico and the United States" (Seman, 2021, p. 14). I will focus on the historical accounts of Don Pedrito Jaramillo since he lived specifically in the Rio Grande region and his cultural influences are still very much a part of people's lives today.

Don Pedrito, as people called him, arrived in 1881 in a US-Texas Borderland city called Los Olmos (now known as Falfurrias). During this time, Spanish was the predominant written and verbal language (Medrano, 2010). However, the cultural backdrop in this area started to shift when the Mexican American war ended in (1846-18-48) and the Treaty of Guadalupe was signed.

> As a result, Mexico ceded nearly one-half of its territory and over eighty thousand Mexicanos living on it. Mexico emerged from this conflict debt-ridden and seeking new political leadership, while the United States faced further division over the slavery issue. Former Mexican territory was viewed by many as conquered land and the

> new Americans, formerly Mexicanos, as conquered people (Medrano, 2010, p.5).

US political interests began Anglo colonization in the RGV. As a result of colonization and modernity ravaging the lands, many Mexicans lost their homes and land at the hands of the Anglos. “Like other forms of colonialism, internal colonialism involved not only the taking of land and resources of the colonized, but inscribing a racial system that defined the colonizers as the legitimate inhabitants and the colonized as the “other,” the invader, the lesser, the dangerous” (Seman, 2019, p. 135-136). Devastation took its toll, and many felt displaced by the social change, marginalized by the blatant oppression and the grief over the loss of their homes and loved ones. Many people sought healing for their emotional and psychological damage that they endured during the racial xenophobia and displacement. Don Pedrito healings were considered a sanctuary to many. People would travel from near and far to receive his healings and hear his stories. These healings and stories would serve as a form of medical care and psychological counseling as many could not afford professional institutions (Zavaletta, 2020). Don Pedrito was revered and celebrated and remained a prominent figure in the RGV. In fact, his contributions to the people in the RGV are recognized by the Texas State Historical Association. Today his shrine, located in Falfurrias, TX, is still visited by many people.

In addition to the contributions of Don Pedrito there have been many curanderos in the RGV. There has been “over 50 years of research that has shown that as many as 80 percent of Hispanics consult curanderos at some time in their lives because curanderos are their only health care resource and it is directed by cultural beliefs” (Zavaleta, 2020, p.10). Research done by Americo Paderes, Zavaletta and many other scholars serves as an epistemological understanding of how ethnobotany via curanderismo a collective experience is shared by “80 percent of

Hispanics "in this region. Ethnobotany in this region is woven into the very fabric of our cultural beliefs and traditional practices and is a knowledge that is valued in Hispanic/Chicano culture.

Although ethnobotany is valued in our culture, it is still not acknowledged at large as a valid way of knowing. In fact, our culture, language, and traditional ways of knowing still conflict with Statesian and Anglophone bounds that directly affect the way education is implemented on a curricular level.

> Statesian and Anglophone bounds, as definition, refer to implicit and often unspoken privilege of US-based and English-language educational traditions, discourses, and practices, even within education deemed “multicultural,” "intercultural," or “international.” These Statesian and Anglophone bounds simply take U.S.-based and English-language research in education unquestionably as “the field” without considering or consulting longstanding pedagogical traditions of educational and cultural criticism in non-English language traditions from other geo-regions (Jupp et al., 2018, p.18).

To consider looking beyond these “Anglophonic bounds” educators need to consider giving students a seat at the proverbial table. This “seat” (e.g. representation) can be achieved by “deep roots in oral cultures and in Latin American human rights struggles” (Bernal et al., 2012, p.363). This representation is essential because according to the National Center for Education Statistics, Latinx students are now the largest minority in U.S. public schools (Aud et al., 2011) “yet notions of diversity in education research only begin to move beyond Statesian and Anglophone

bounds in U.S.-based educational contexts" (Jupp et al., 2018, p.18). The lack of representation of cultural diversity within the curriculum causes students to feel "invisible" or disenfranchised.

Existing in the Liminal Spaces

In my previous section, I provided a historical overview of the RGV, cultural implications of ethnobotany, and the significance of ethnobotany to this specific community. Although ethnobotany is a biological science and an indigenous cultural way of knowing embedded in the RGV, it is dismissed in schools and is not acknowledged as "valid". This brings the question whose knowledge counts? And what counts as science? I begin my investigation of these questions by describing my own childhood educational experiences in science classrooms. Although my traditional knowledge of plants and holistic medicines ignited my passion for learning science, my innate curiosity of the natural world was stunted for many years by the very educational system that should have incubated it. In a sad truth that is equal parts irony and tragedy, elementary science education doused this fire for most of my childhood by essentially teaching me that I was not a scientist by virtue of my identity. As a Chicana from the Rio Grande Valley, I grew up with a sense of "otherness" that was pervasive throughout my educational experiences. Neither my knowledge of ethnobotany nor my gender was welcome in science education according to the patriarchal, hegemonic ideologies pervasive in RGV schools and their greater cultural backdrop. Thus, this section of my testimonio explores a deeper understanding of the personal impact caused by subtraction of my culture, knowledge, and language from the science classroom. I will also explore the ongoing prevalence of subtractive schooling (Valenzuela, 1999) in science classrooms today.

Growing up in the Rio Grande Valley, I remember that most of my primary and secondary school years were confined to rows of seats. The format for teaching was mostly

didactic lecture and learning was a process of rote memorization. I disconnected from the experience, often thinking only of how bored I was and that I never wanted to be a teacher. It never crossed my mind that teachers could inspire students; teachers were simply providers of role and stereotype indoctrination. While boys learned, teachers told girls stories of the "old ways", emphasizing bluntly that science cannot fit into their lives: "Ninguna ciencia pequeña no es para niñas. Recuerda, debes ser una buena nina para poder casarte algún día." I refused to believe the elementary teachers that tried to convince me that Science was not for girls and fought against the thought that my only role as a female was to behave and be good so that I may be a wife one day. As a child I struggled with this pervasive "cultural tyranny" (Anzaldúa, 1987) and specified gender roles. I often rebelled. I felt like a tiny warrior fighting cultural tyranny on both fronts at home and at school. I existed in a liminal space.

Liminal spaces in this context are described as a feeling of being caught an-in between space of assimilation and their sense of cultural being as they move from one border to the next (Anzaldúa, 1987). Anzaldúa explains that this state of being is known as 'nepantla'. The state of nepantla state confronts "the fact that there are many ways of knowing, that epistemologies also exist outside the western ideology, and that we have many possibilities of learning, being and expressing outside the rigid categories that aim to construct peoples' identity in one particular way" (Orozco-Mendoza, 2008, p.46). The understanding of liminal spaces further advances my study as it addresses Chicanas feelings of "otherness". In addition, this feminist lens "bridges" the "conceptual beginning points of understanding and theorizing about Chicanas/Latinas in educational" and transnational contexts (Bernal, 2006; Pérez Huber, 2017, p. 376).

These "othering" experiences extended into home life as well, further alienating Chicana learners from pursuing STEM education. For instance, although my mother was always

supportive, she had succumbed to the pressures of gender norms. I remember being told that I could not attend Sci-tech or any schools that were considered too far because I was a Hispanic girl, and good Hispanic girls could not go anywhere far without being escorted. My younger brother, naturally, was not placed under any such restrictions. Any dreams of becoming a scientist or a doctor seemed that much more impossible every time my parents would beam with pride about their boy at Sci-tech. At the time, I also thought that if the teacher could give us something to do outside the classroom, I would have a chance to show my teacher and my parents that I could be a scientist. However, like their traditional notions of feminine gender roles, schools were focused on traditional methods of teaching: worksheets, rote memorization, silent reading, and being quiet. I felt helpless, and as a result, I disengaged.

I needed things to change. I yearned for teachers to address the gender stereotypes pervasive in our schools and provide hands-on activities to enrich our classrooms. These are concepts I knew even at that young age but was not able to put words to. It wasn't until secondary school that I had my first experience with place-based pedagogy (PBP), and as a Chicana girl disenfranchised from science, that experience restored my passion for science. We were taken on an unforgettable field trip to Sabal Palm Sanctuary, where we were tasked with observing the native birds in their natural habitat. Throughout the semester, the teacher addressed issues such as pollution in our area and the impact on the beautiful local wildlife we had observed. She emphasized the importance of taking care of our environment locally and globally, encouraging the development of "critical consciousness…to engage the world and others critically" as described by Ladson-Billings (1995). Through the use of culturally relevant activities combining local wildlife, local politics, and conservation efforts as recommended by Guajardo (1997), this teacher encouraged us to build a sense of community and feel connected to

our learning. Her utilization of local resources built a bridge between the theory in our textbook and the world beyond the classroom walls. As a direct result, my childhood passion for ethnobotany rushed back to me, and I remembered everything that I loved about learning science. Science education had suddenly become relevant, meaningful, and engaging, and pursuing it finally appeared to be in my grasp.

If it had not been for the teacher that acknowledged my cultural ways of knowing, funds of knowledge, and connecting her lesson back to the land, I probably would not be writing this paper now. To this end, I posit that the curricular shift in early childhood education must be forged by approaching the science curriculum through a decolonial lens.

Forging a New Path

This critical inquiry approaches science education through a decolonial lens by attempting to address the hegemonic science curriculum that excludes feminist approaches and borderland epistemology by proposing a decolonized approach that leverages testimonios as cultural capital to specifically inform the development of Chicana preservice teachers. This feminist lens is essential to this study since it recognizes the lived experiences, cultural intuitions, and collective cultural Chicanx indigenous knowledge, beliefs and language that is embedded in Chicanas ways of knowing (Huber & Villanueva, 2019; Pérez Huber, 2017).

This acknowledgement opens a discursive space where Chicana shares alternative ways of knowing utilizing testimonios as a tool for engaging, learning and reflecting. In turn, these reflective spaces allow Chicana to begin to form critical consciousness along with pedagogies of resistance. According to Trinidad Galván (2006) pedagogies of "resistance encompass personal, collective, spiritual, and survival undertakings" (p. 175). These tools of critical consciousness and pedagogies of resistance are imperative for transformational praxis in Chicana preservice

teachers (Freire, 1970). Furthermore, this study explores a decolonial approach to facilitate a notion of conscientization by leveraging cultural ecological ways of knowing through their own cultural indigenous knowledge of the land and history of their region. Specifically, this study explores what are the testimonios of Chicana preservice teachers and how does this inform their understanding of critical approaches in science education in early childhood classrooms?

Overview of Upcoming Chapters

In Chapter 2, I will elaborate on my proposed decolonial approach by utilizing literature that emphasize underpinnings of social justice, Chicana feminist epistemologies, critical based pedagogies, land-based education, and pluralistic and culturally sustainable practices to articulate culturally sustainable practices relevant to Chicana preservice teachers in our region and beyond. The literature that undergirds my research is vast. I categorize literature into six dimensions. These six dimensions are carefully interwoven together forming intersecting pieces that overlap and form an overall framework that drives this inquiry. These dimensions include the following: 1) Rawlsian social justice (Rawls, 1971); 2) Chicana feminist epistemologies (Bernal, 1998); 3) land-based education (Calderón, 2014); 4) critical place-based education (Gruenwald, 2003b); 5) pluralism and cultural sustainability (Mueller & Bentley, 2007; Sousa Santos, 2007); and 6) Paulo Freire's notion of conscientization (Freire, 1970).

Chapter I Summary

Chapter 1 explores the significance of Chicanas' understanding of their own culture, teacher identity, and critical consciousness. I utilize personal narratives of my own lived educational science experiences to highlight the tensions between ethnobotany (e.g., cultural ways of knowing) and Western science curriculum. Along with my narrative, I describe the history of the region to inform the broader cultural context of local Chicanas' relationship to

these topics. Using these elements, I begin to unpack my research question: What are the testimonios of Chicana preservice teachers and how does this inform their understanding of critical approaches in science education in early childhood classrooms? This question shapes my critical inquiry as I begin to explore how elementary Chicana preservice teachers in the Rio Grande Valley region leverage their own lived experiences in culturally based indigenous ways of knowing into their own teaching practice.

CHAPTER II

CONCEPTUAL INFRASTRUCTURE

"Until the lion learns how to write, every story will glorify the hunter."

~African proverb, author unknown

I seek to dismantle the social injustices of subtractive schooling and curriculum epistemicide (Valenzuela, 1999; Paraskeva, 2016) within science education via the application of the Community Learning and Ecological Sustainability Paradigm (CLESP), a novel conceptual framework integrating six, carefully interwoven dimensions: 1) social justice, 2) Chicana feminist epistemologies, 3) land-based pedagogy, 4) critical place-based pedagogies, 5) pluralism and ecological sustainability, and 6) pedagogical praxis.

Figure 1: Community Learning and Ecological Sustainability Paradigm (CLESP)

Dimension 1: Social Justice

The description of CLESP begins with the theoretical underpinnings of Rawlsian social justice. Rawls' tenets of social justice are applicable to this inquiry as we examine how "marginalized students make meanings about science, negotiate spaces for legitimacy, or cross borders within science classrooms to find ways to succeed" (Dimick, 2012, p. 992). In this section I will begin by briefly reviewing Rawls' concepts of justice. These concepts are presented in a lexical discourse. Lexical discourse means that each concept will build upon one another, shaping the basic premise of social justice, as well as defining what "fairness" and "equality" mean within the context of an educational setting. For my inquiry, I will be drawing on only three of Rawls' tenets: 1) basic liberties; 2) equal access to opportunity; and 3) the difference principle. How these tenets can be applied within the scope of science curriculum will be reviewed in the subsequent sections below.

The term social justice is an egalitarian principle that advocates removing inequalities. According to Rawls (1971), "the concept of justice is the role of its principles in assigning rights and duties and in defining the appropriate division of social advantages" (p. 9).

Basic Tenets of Rawlsian Social Justice

Tenet 1: Equal Rights. The first principle outlines how each person has a right to basic equal rights. These equal rights would give the person the opportunity to receive equal access to resources which allow them to compete and be successful as they would also have the social advantages to resources despite their ethnicity, socioeconomic status and culture. By providing equal access, people would be granted an equal opportunity to "work together in such a way as (a) to encourage contributions that (b) increase the production of goods and services, which in turn are so distributed as to (c) improve continually the level of income and wealth of all the

various income groups involved" (Boucher & Kelley, 1994, p.252). In other words, if we give people basic rights such as an equal and equitable education, they in turn will be able to contribute to society and can obtain wealth.

Tenet 2: Basic Liberties. The second principle highlights the basic liberties that should be provided within educational institutions. After all, the notion of equal basic rights to free public education is one of the fundamental concepts of our nation's educational policies. This policy is often displayed as equity and equality on schools' marquees signs. These terms "equity" and "equality" are synonymous with this Rawls ideology of fairness as equity. This means that schools should provide resources and support to students that are disadvantaged and thus provide an equal opportunity for all students to participate in their academic discourse. Unfortunately, this is not the case. We often see an unequal division of resources within communities. This uneven distribution is due to the fact that our society was built on the premise of a utilitarian structure. Utilitarianism means that resources are given to the greater good; however, in this context it means that resources are often allocated towards areas that are affluent rather than areas that are marginalized. This is visibly seen throughout the colonias in the Lower Rio Grande Valley. These colonias have high rates of poverty, poor housing quality, and insufficient infrastructure and utility service (Durst, 2014). The schools in these surrounding rural areas receive less science funds and resources than those in more affluent schools. This uneven distribution of public-school funding and resources causes an inequality that inadvertently affects student's outcomes. "Rawls believes that significant inequalities in outcome (inequalities sufficiently great to affect one's lot in life) stem in important ways from differences in people's natural endowments and in their initial social circumstances" (Boucher & Kelly, 1994, p. 252). In other words, if you are born poor and live in a rural area where schools may not

receive the same basic liberties to a fair and just system that gives you the ability to gain social opportunities. In this case, the uneven division of resources causes a social disadvantage which further perpetuates an academic apartheid between schools in low-income areas than those in affluent areas. This academic apartheid is perpetuated by the utilitarian structure within the sociopolitical structures in the school districts. This embedded structure does not distinguish between the poor class and the upper class (Rawls, 1971) instead this system favors more affluent areas under the guise of the greater good.

To counter the social political structures that divide the classes, Rawls suggests that we should "consider how the social system looks to certain representatives of individuals" (Rawls, 1971, p. 81). Rawls' suggestion purports that we should consider an individualistic approach to people's needs rather than an approach targeting just the few — that is, the privileged. I will discuss how these ideologies may be conceptualized through educational infrastructure later in this text.

Tenet 3: Difference Principle. Rawls' third tenant the difference principle states, "that in order to treat all persons equally, to provide genuine equality of opportunity, society must give more attention to those with fewer native assets and to those born into the less favorable social positions." (Rawls, p. 86) This principle is important to my inquiry since it specifically highlights the need to "give more attention" to people in highly marginalized areas. In my inquiry, we are looking at the Chicana population specifically since they are highly underrepresented in STEM. Also, many Chicanas in rural populations are under-served and thus may not have the same basic liberties to obtain the academic fair advantage in competing in STEM fields. Thus, in this next section I will discuss how each of the principles may be applied through an educational context in order to address disparity.

Rawlsian Principles Reimagined through an Educational Lens

In this section we will discuss how Rawls' three principles and their social justice underpinnings can be reconceptualized through an educational lens. Rawls proposed that people should have access to basic liberties in order to help people be successful and productive. This basic liberties ideology was written towards promoting an economic impact, the outcome in promoting the same basic liberties within an educational institution has the same goal. It stands to reason that if we provide people with equal opportunities to learn by using the basic liberties such as their own native language, culture and ways of knowing then people will have a "social advantage" and thus be able to compete equally in an educational setting which leads to success in the workforce. In this regard we apply Rawls's difference principle that states that we should "give more attention to those with fewer native assets and to those born into the less favorable social positions" (Rawls, p. 86).

This facet is important to recognize since the National Center for Education Statistics claims that Chicana/Latinx students are now the largest minority in U.S. public schools (Aud et al., 2011), "yet notions of diversity in education research only begin to move beyond Statesian and Anglophone bounds in U.S.-based educational contexts" (Jupp et al., 2018, p. 18). The lack of representation of cultural diversity within the curriculum causes students to feel "invisible" or disenfranchised. Thus, it is imperative that we transform the oppressive infrastructure of education by suggesting a democratic curricular approach instead. The reimagining of Rawlsian social justice through an educational lens advances the notion of democratic schooling as we begin to view education as an individualized approach instead of the standardized "one size fits all".

To counter this “one size fits all” curriculum, we can consider Rawls second tenant of basic liberties. Rawls' basic liberties tenant suggests that we look at the social system and how it affects all individuals (Rawls, 1971). In essence this purports that we should consider differentiated approaches in both curriculum and pedagogy. In doing so we account for socio-economic factors that may influence a student’s performance. By acknowledging these differences and recognizing student's individual needs we begin to leverage students' capital. In leveraging our student's capital, we build towards sustainability, equity and equality which are the foundations of Rawls ideological tenets. In the following subsections below, I will elaborate on how we can use these ideologies to begin to build towards sustainable teaching and learning by specifically looking at funds of identity and epistemic agency.

Funds of Identity. Rawl’s theory of justice is an egalitarian approach that distributes equality for all. This concept is essential for marginalized populations that continue to remain underrepresented in STEM fields. The question is how do we apply these principles and restructure the way social justice is viewed in an educational setting? I posit that we begin to reconstruct social justice at the institutional level by considering integrating funds of identity and epistemic agency into our curricular frameworks.

According to Rawls (1971) we need to provide basic liberties to all people so that we empower individuals to have equal rights and access to resources that would allow them to compete in society. These “basic rights” include but are not limited to a curriculum that is inclusive of funds of identity, bilingualism, and cultural ways of knowing. The application of funds of identity may promote a sense of agency, fostering a space where people are being acknowledged and valued. However, in order to consider funds of identity as a facet within a social justice framework we need to address perception of deficit. Teachers assume students from

low socio-economic backgrounds have a knowledge deficit. This negative assumption creates a rift within the climate of the classroom and may cause students to feel invalidated. Similarly, Hogg & Volman (2020) state that deficit perspectives are rooted in negative assumptions about a students culture and family. As educators we must begin to:

> break down deficit thinking and to enhance the inclusivity and equity of education by acknowledging and building on knowledge and skills that students acquire out of school and define as important aspects of their identity. (Hogg & Volman, 2020, p.864)

In doing so, educators create a learning climate that promotes the basic liberty of accessible resources equitably for all students since they are using facets of their own identity as a sense of agency (Rawls). Saubich and Esteban (2011) codify this idea by stating that:

> We suggest the term funds of identity to refer to the culture-bound stories, technologies, documents, and discourses that people internalize and construct in order to make sense of the events in their lives; funds of identity which allow them to reach a self-understanding and to communicate that understanding to others (p. 84).

This is applicable to my inquiry since exploring the meaning of science is built upon the premise of your own inquiry and identity. Thus, science educators should build upon students' rich experiences that they bring with them in their "virtual backpacks" (Thomson, 2002). This critical approach fosters equitable school outcomes by embracing a curriculum that validates and nurtures diverse identities of minoritized students (Swartz, 2009). In essence, this critical approach embraces social cultural capital which bridges students' knowledge to scientific

literacy. In doing so, we create a paradigm shift out of the prescribed curriculum into a democratic classroom, thus shifting the power differential back to the students and promoting epistemic agency.

Epistemic Agency. Epistemic agency gives the power back to the students, allowing them to seek answers by investigating science through their own inquiry processes. The exploration of their own process and identity as scientists begins to shift the curriculum by empowering students as epistemic agents. In doing so, educators challenge students to engage in continuous critical reflection which challenges their own worldviews and ideologies. In addition,

> critical pedagogy acknowledges that power relations in society are reproduced in the classroom and sees the classroom as a site where teachers and students can challenge and contest these relations (Tilley & Taylor, 2013, p. 409).

Moreover, epistemic agency fosters "social emancipation that is premised upon replacing the 'monoculture of scientific knowledge' by an 'ecology of knowledges'" (Sousa Santos, 2003b; 2004a, as cited in Sousa Santos, Nunes, & Meneses 2008, p. xx). As we move towards epistemic agency we acknowledge and empower those who were marginalized.

In contrast, traditional science classrooms are taught in a "conservative" manner in which the teacher is the "sole instructional, knowledge, and practice authority — the only epistemic agent in a classroom" (Stroupe, 2014, p. 488). Students are treated as empty vessels and teachers pour their knowledge and content through positivistic mechanisms. Teachers are "authoritative transmitters of knowledge and receptive vessels (Freire, 1970) are the primary roles, respectively, that instructors and students play in many traditional classrooms. Tasks in a typical classroom consist of passive learning where the teacher often lectures, and the students sit there

and listen or just copy what the teacher states. Once we begin to recognize that students are knowers and doers in science, we begin to decolonize power by fostering different opportunities to learn "other ways of knowledge" (Sousa Santos, 2008).

Although Rawls' work faced criticism for his romanticized notion of Utopian egalitarian social justice in a utilitarian world, the reconceptualization of his work paints the possibility of transforming the hegemonic institution into a more democratic system. Rawls' tenants provide some foundational ideas on how we can begin to shift social injustices at the institutional level. I contend that for social justice to be reconceptualized, we must focus deeply on those who have been oppressed and marginalized. I will be focusing on the Chicana population.

Dimension 2: Chicana Feminist Epistemology

The standardized hegemonic science curriculum creates a climate of otherness that alienates and subtracts cultural values, indigenous knowledge, beliefs, and language that is embedded in Chicanas ways of knowing. This alienation creates a feeling of "otherness". Staszak (2009) defines "otherness" as:

> the discursive process by which a dominant in-group (us, the self) constructs one of many dominated out-groups (them, other) by stigmatizing a difference real or imagined-presented as a negation of identity (p. 2).

I include the dimension Chicana Feminist Epistemology (CFE) to directly address this shared experience of alienation. CFE critically counters oppression by embracing and celebrating:

> "a unique social and cultural history and demonstrates that our experiences as Mexican women are legitimate, appropriate, and

> effective in designing, conducting, and analyzing educational research" (Bernal, 1998, p. 563).

This is essential because this inquiry takes place in the Rio Grande Valley, which has one of the highest percentages of Chicanx populations in the United States.

It is imperative that we empower preservice teachers by removing the structural barriers that suppress agency in research that values Chicanas' lived experiences, cultural intuitions, and collective understanding, which they can, in turn, provide to their students. CFE is unique in that it values and highlights cultural intuition, which allows us to "move from largely patriarchal ways of seeing the world to learning to listen to our inner voices, to trust our intuition, and to interpret research outside existing paradigms" (Diaz Soto, 2009, p. 168). According to Bernal (1998), cultural intuition is composed of four facets that produce a critical social justice approach within research and scholarship.

The first facet of cultural intuition is Chicana's personal experience. "Personal experience does not operate in a vacuum" (Bernal, 1998 p. 564). Instead, personal experience is composed of experiences from ancestors, elders, and the knowledge they "carry of conquest, loss of land, school and social degradation, labor market stratification, assimilation and resistance" (Bernal, 1998, p. 564). This knowledge is imperative since we aim to connect, understand, and value our community's knowledge. As community practitioners, we integrate Chicanas and other ways of knowing and living experiences by utilizing the community's knowledge as cultural capital. Knowledge in the community "is taught to youth through legends, corridos, storytelling, and behavior" (Bernal, 1998, p. 564). Community knowledge can be leveraged in order to empower and produce more critically conscious Chicana preservice teachers, thus fostering agency and self-efficacy.

The second facet of cultural intuition is found in existing Chicana literature such as "theoretical writings, philosophical writings, non-technical literature, public documents, personal documents, and cultural studies writings" (Bernal, 1998, p. 565). These sources and materials enhance cultural intuition as they provide sources of data that can be used to make meaningful connections to explored phenomena. This is essential as Chicanas need relevant literature that represents their sense of place, agency, and cultural values. This literature also provides a sense of collective experiences that are validated by various sources and shared personal experiences:

> Most importantly, while Chicanas/Latinas find themselves in the field of education but not divorced from the theories that have inspired and uplifted their lives—and indeed have utilized Chicana feminist perspectives in their research—there has not been an explicit and systematic articulation of the connections between Chicana feminist thought and the field of education (Bernal, 2006, p. 3).

The third facet of cultural intuition is professional experience. Professional experience entails "years of practice in a particular field [that] often provides an insider view of how things work in a particular field" (Bernal, 1998, p. 566). Chicana preservice teachers' identity is shaped by cultural experiences, language, and personal experiences; these are reflected in their teaching practices. Thus, they bring cultural attributes into their own classroom.

The fourth facet of cultural intuition is the analytical research process. This requires that "researchers and participants deconstruct the epistemology of the participants and use it for the entire project" (Bernal, 1998, p.74). This facet is critical in that it challenges the tension between objectivity and subjectivity. "Objectivity is a universal foundation of knowledge, and the

Western dichotomies of mind versus body, subject versus object, objective truth versus subjective emotion, and male versus female" (Bernal, 1998, p.4). Furthermore, objectivity in this context allows the Chicana preservice teachers to view culture and experiences as collective differentiated experiences rather than a single insular experience. This is crucial as we consider that:

> Chicana epistemology maintains connections to indigenous roots by embracing dualities that are necessary and complementary qualities and by challenging dichotomies that offer opposition without reconciliation (Bernal, 1998, p.560).

In other words, the analytical research process encourages Chicana preservice teachers to consider existing dualities, thus becoming more critically conscious. This is valuable in science education and research since science claims to be objective. Science is inherently subjective; the researcher carefully crafts each detail of the experiment based on their own observations, expectations, and designs. Hence CFE's aspect of cultural intuition is instrumental since it acknowledges the subjectivity and objectivity in science. Embracing both of these dualistic concepts legitimizes knowledge and science processes within the scope of science curriculum.

Combining these four facets, the use of CFE challenges science curriculum to explore ways of knowing by:

> "validating alternative sources of knowledge as appropriate for learning, Chicana feminist epistemologies provide Chicana educators the ability to deconstruct the teacher/student binary common in all levels of schooling and move toward decolonizing pedagogical models" (Calderón et al., 2012, p.519).

Furthermore, the use of CFE within the curriculum disrupts traditional ways of teaching and learning by allowing pedagogical interventions that reconceptualize the way women learn in "communities and formal institutions as cultural knowledge, cultural politics, and practices of well-being" (Bernal, 1998, p. 164). Although this component of the literature discusses aspects of addressing social justice for women of color, specifically Chicana women, it does not elaborate on the Chicana's "community knowledge". According to Bernal (1998), "community knowledge" acknowledges the historical, social, and cultural ecology of knowledge that is localized within a region. This community knowledge or conocimiento of the land should be considered as cultural capital and included in the science curriculum. Thus, I expand on "community knowledge" by weaving in the third dimension of Land-Based pedagogy into my literature.

Dimension 3: Land-Based Pedagogy

In order to build on a student's "community knowledge" as cultural capital, we must first understand where students live or come from. For my third dimension, I draw on Calderón's (2014) notion of decolonizing land-based pedagogy. Land-based pedagogy is built upon understanding land-based environmental perspectives of ecological sustainability and cultural values in that it articulates stories of the indigenous peoples in a given region. Such stories include historical facts, native languages, indigenous medicines, and agricultural practices that are otherwise dismissed by standardized Western scientific curriculum (Calderón, 2014). Furthermore, land-based pedagogy is an essential part of critical placed education as it connects "how place in the US has been inexorably linked to the genocide of Indigenous peoples and continued settler colonialism" (Calderón, 2014, p. 25). This critical pedagogy highlights the epistemicide (Paraskeva, 2016) of peoples' culture and the need for decolonization.

The integration of land-based pedagogy is a critical approach in that it analyzes how colonization has affected the legitimacy of indigenous knowledge and what constitutes as science through a decolonized lens. By rejecting the "anthropocentric and Eurocentric understandings of land and citizenship" (Calderón, 2014, p. 25), we start to analyze how colonization has influenced curriculum textbooks and identify how "settler identities are produced through schooling processes associated with settler legacies that underlie the diversity of land relations in the US. An important starting place for understanding how educational models produce colonial understandings of place is to focus on how settler ideologies in educational tools such as textbooks construct and make sense of the world in ways that maintain settler colonialism" (Calderón, 2014, p. 25). By recognizing how the curriculum is saturated in colonial ideologies we start dismantling the hegemonic curriculum while building towards sustainability. It is here that we "achieve goals of sustainability and the wedded notion of community building" (Calderón, 2014, p. 25).

This decolonial approach challenges the status quo of a one size fits all approach to scientific knowledge by recognizing the importance of ecological indigenous knowledge (e.g. ethnobotany; Aikenhead, & Ogawa, 2007). This is critical to my inquiry as Chicana Preservice Teachers previously reported that although they felt disconnected from science, they had a rich connection to culturally significant home remedies practiced by their families (Nouri, Aguilar, & Ramirez-Biondolillo, 2020). This rich cultural connection of remedios caseros (ethnobotany) is "community knowledge" and is connected to the prevalent "cultural intuition" within the Rio Grande Valley. This ecological indigenous knowledge of remedios caseros has been passed down from generation to generation for centuries. The remedies in this context feature this region's

cultural intuition and indigenous knowledge towards sustainability of the local bioregional resources.

This is critical to my inquiry since Chicana Preservice Teachers previously reported that they "feel disconnected and that the lack of cultural relevance is the reason they did not understand science and thus began to dislike it" (Nouri, Aguilar, & Ramirez-Biondolillo, 2020). In a previous study by Nouri, Aguilar, and Ramirez-Biondolillo (2020), one Chicana preservice Teacher criticized the teachers she experienced as a child for not including any activity relating to the community in her lesson plans. Her narrative expressed that "I don't remember any of my teachers throughout my school years who even tried to connect science to my community, school, or culture. If I had some connections between science and my personal life, I think I would have been more interested in the subject."

To address this disparity, it is imperative that land-based pedagogy be centered on the notion that students understand how colonization has impacted the land, culture, language, and history. In this regard, land-based pedagogy encourages students to understand their context of place within their past, present, and future, shaping who they are today in their community (Calderón, 2014; Pendleton Jiménez, 2006). This critical approach bridges the gap between disenfranchised Chicanas with science learning, science education, and science curriculum while emphasizing sustainability and critical consciousness.

According to Calderón (2014), land-based education is essential as it promotes critical connection: "Land education is important for environmental educators and students because it asks them to rethink their relation to land as a dynamic ecological and cultural project of recovery and rehabilitation" (p. 33). Moreover, land education challenges educators to consider the implications of ecological sustainability as well as how land education is connected to

teachers' own identities (Calderón, 2014). This approach is essential as we aim for land stewardship that impacts the environment and critical consciousness toward teacher praxis within the preparation of Chicana preservice teachers. In order to expand on the aspect of "community knowledge", indigenous ways of knowing, and ecological sustainability, we must "emphasize community needs and engagement" (Calderón, 2014, p. 33). "In this regard, Gruenewald's (2003a, 2003b) work, pairing critical pedagogy with place-based education and promoting place-conscious education, is a step in the right direction" (Calderón, 2014, p. 26). Thus, I weave in place-based education as the fourth dimension of my pedagogy model.

Dimension 4: Critical Place-Based Pedagogy

For my fourth dimension, I merge the previous literature above weaving Chicana's cultural intuition, community indigenous knowledge, and ecological sustainability, connecting them to place-based education. I draw on Gruenwald's (2003a, 2003b) place-based consciousness and Guajardo et al.'s (2006) Llano Grande place-based pedagogy within the Rio Grande Valley. I draw specifically on critical place-based pedagogies because of its history of direct connection to subject area teaching, such as science teaching in schools. Critical place-based education leverages Chicanas' own lived experiences, cultural intuition, community knowledge to build critical consciousness and awareness within their own science education practices.

Critical place-based pedagogy refers to a curriculum that leverages our immediate natural surroundings to explore the scientific natural world, using local resources to encourage ecological knowledge, stewardship, and community engagement. This critical pedagogy fosters "a mutual construction of knowledge" in which the students get to "forge intimate relationships for growth" (Pohl, 2013, p. 44) between their culture, history, and ways of knowing. In this sense critical pedagogy is also culturally relevant pedagogy as it leverages biliterate, bicultural

approaches in order to enhance the acquisition of scientific language. In addition, Chicana preservice teachers can use communities, land partnerships, local resources, and the local native languages as a foundation in developing cross-multidisciplinary studies as well as reinforcing scientific language acquisition. This is essential to science curriculum, as research has shown that acquisition of scientific language in a successful science classroom is the "ability of teaching to weave together the science content with the students' life outside of school" (Brown & Spang, 2008, p. 2063). Thus, the ability to integrate the students' knowledge of local land, local language, and local community helps the students establish a deeper connection with their culture and funds of knowledge while building their cognitive academic language proficiency. Moreover, place-based pedagogy allows us to navigate the in-between space of planned and lived curriculum so that we may understand the "role of socially constructed differences such as race, class, gender, and micro/macro structures play in shaping teaching and learning that occurs in classrooms" (Tilly & Taylor, 2018, p. 409). By incorporating relevant activities with the local community, the students establish a personal connection with the subject matter, thus establishing a sense of place (Semken & Freeman, 2008).

This applied approach to scientific knowledge emphasizes the ability to creatively address real-world problems relevant within their own communities. This "pedagogy becomes more relevant to the lived experience of students and teachers, and accountability is reconceptualized so that places matter to educators, students, and citizens in tangible ways' (Gruenwald, 2003b, p. 620). According to Sobel (2008), place-based helps science curriculum become tangible by allowing the student to become the center of the curriculum through the process of lived experiences and experiential learning. Furthermore, "place based, or place conscious education introduces children and youth to skills and dispositions needed to regenerate

and sustain communities" (Gruenwald & Smith, 2008, p. xvi). It aims to achieve this end by drawing on local phenomena as the source of at least a share of children's learning experiences, helping them to understand the processes that underlie the health of natural and social systems that are essential to human welfare" (Gruenwald & Smith, p. xvi). This critical pedagogy also redistributes the power back to the students and provides a sense of epistemic agency (Stroupe, 2014).

A powerful example of how critical place-based learning fosters epistemic agency is the Llano Grande Center project. The Llano Grande Center project is located in Rio Grande Valley at Edcouch-Elsa High School. The aim of this project was to empower local youth in curricular decision making. The participants at the Llano Grande Center engaged as co-constructors of the curriculum, expressing their own voices in the pedagogical decisions utilized in this project; they stood in their own agency and power (Guajardo ,et al. 2006).

Critical pedagogy in science education "allows us to interrogate some of historical, theoretical, and practical contradictions that have challenged the field and to consider science learning as part of a broader struggle for justice and democracy" (Giroux, 2010, as cited in Lodge, 2021, p. 612). This additional context encourages dialogic discussions and critical consciousness, promotes ecological stewardship, and generates sustainable practices that may be carried on from one region to the next (Gruenwald, 2003a; Sobel, 2008). In this way, critical pedagogy counters the conventional ways of conceptualizing what counts as science, as it presents students with an equal opportunity to creatively address real-world problems relevant within their own communities (Sobel 2008). Thus, "place-based education is also consonant with the landscapes of pluralism (gender, multiculturalism, and the Earth's natural environments) in science education" (Mueller & Bentley, 2007, p. 329). Pluralism and ecological sustainability are

essential in the science curriculum as it acknowledges that there are a multitude of cultural beliefs that may change from region to region: one size does not fit all (Suldovsky et al., 2018). It is imperative to consider pluralism as a critically conscious science-based approach since it encompasses ecological sustainability that connects one's own environment.

Dimension 5: Pluralism and Ecological Sustainability

The fifth dimension of the model draws from Mueller & Bentley's (2007) notion of pluralism in Science Education. In this section, I will discuss how we may counter hegemonic conventional science classrooms and transform them into democratic classrooms that value equity, cultural intuition, community knowledge, ecological sustainability, and pluralism.

Science has been taught though a Western globalized approach that has devalued contributions of indigenous community knowledge and other ways of knowing (Mueller & Bentley, 2007; Sousa Santos, 2007). According to Mueller and Bentley (2006), this Western perspective contextualizes and places science as a "decorated landscape". Mueller and Bentley's (2006) euphemism of "decorated landscapes" depicts classrooms that are riddled with textbooks and worksheets that support the standardized curriculum. This form of prescriptive teaching has decontextualized science and perpetuated epistemicide through oppressive hegemonic systems. To move beyond these oppressive "decorated landscapes" we must consider science reform that "prepares students to make informed choices and fully participate in society in ways that are reflective, reliant, and reciprocal of Earth's many natural environments that sustain life itself" (Mueller & Bentley, 2007, p. 323). Thus, we begin to look towards pluralism and sustainability.

Pluralism acknowledges that indigenous knowledge and culture is constantly evolving; therefore, our approach in science and the way we view science must also constantly evolve (Paris & Alim, 2014). I utilize pluralism in this context so that teachers may begin to look at

their approach in teaching and in learning through a cultural pluralistic lens. This is critical to my inquiry as plurality is inclusive in that it allows each culture to maintain their own authentic identity, culture, gender, race, ethnicity, religious background, class and socioeconomic status (Mueller & Bentley, 2007). My pedagogical aim in this study is to give students an opportunity to express "voices of the past, present, and future as equal stakeholders in democratic life and in the Earth's natural environments: not constituents of one reality but of many equally important realities" (Mueller & Bentley, 2007., p. 327). Literature in this vein argues that by providing voice to the students, we give them an equal opportunity to represent themselves in a manner that reflects their own cultural values founded in their respective bioregions and ecosystems (Mueller & Bentley, 2007; Ladson-Billings, 2004; Ladson-Billings, 2006a; Ladson-Billings, 2006b; Roth & Barton, 2004; Thayer-Bacon, 2000; Thayer-Bacon, 2001; Thayer-Bacon, 2002).

Using pluralism as a critical pedagogy, we shift the "decorated landscapes" into a relevant curricular approach that incorporates indigenous ways of knowing such as ethnoscience and ethnobotany. This is essential since, as Turner et al., (2022) asserts, ethnoscience and ethnobotany are very much a part of other ways of knowing. In this study, I argue that this notion of pluralism as a critical pedagogy is especially important in the RGV. According to Reiss (1993), it is unfortunate that many students "have no idea of the extent and significance of the contributions made to science by non-Western cultures" (p. 13). Therefore, if we want to value funds of identity and indigenous ecological knowledge, we need to create "a world where the educational landscape is shifting as it attempts to grapple with global issues, and where we, as critical pedagogues, provoke global citizenship and wakefulness in our students" (O'Hara, 2006, p. 25). In doing so, we promote a sense of scientific literacy that transforms the community into

citizen scientists (Roth & Barton, 2004) while also invoking Chicana preservice teachers into becoming critical consciousness practitioners.

Dimension 6: Pedagogical Praxis

The sixth dimension of the model, pedagogical praxis, intersects each of the previously reviewed dimensions and is the nexus of the CLESP framework. Drawing from Freire's (1998) notion of praxis and Giroux's (2016) notion of critical pedagogy, CLESP challenges the standardized hegemonic science curriculum that excludes Chicanx cultural representation by approaching science teaching and learning through a democratic lens. According to Justice & Tenore (2017) we should prepare teachers to look beyond the prescribed curricular models and begin to seek alternative critical pedagogies that foster pedagogical praxis. This requires us as educators to advocate for social change while transforming learning and teaching opportunities that engage students in meaningful dialogues that elicit reflection and action in the world around them. Likewise, Freire (1998) emphasizes this concept by stating that "thinking critically about practice, of today or yesterday, makes possible the improvement of tomorrow's practice" (p. 44).

By engaging in this constant state of challenging ourselves as reflective practitioners, we start to reach a state of critical conscientization (Freire, 1970). Critical conscientization is predicated on how we reflect through our own reality and the action we take to address the social injustices found within the confines of our communities. In this respect critical conscientization can be considered the antecedent of praxis since we must first be aware through our own reflection of the world around us. The act of bringing forth this change and addressing the problem within the community through participatory action is then translated into praxis. Freire's notion of praxis bridges theory and practice through a reflective critical analysis. Pedagogical praxis emphasizes a constant need for evolving teaching practices in response to oppressed and

disenfranchised students (Freire, 1970), serving as a nexus for the elements of this framework. The culmination of these elements empowers students and educators by utilizing students' cultural capital, teaching scientific literacy through funds of knowledge rather than a rote memorization of facts and definitions, promoting naturalistic student learning, and fostering deeper connections to the curriculum. By providing these deeper connections, we provide the opportunity to "become conscious of the world as expressed through the educator's language, conceptual understandings, multiple perspectives, and ever-changing existence, that is, historical background, cultural characteristics, living conditions, and so forth" (Gallavan & Webster-Smith, 2012, p. 404). In other words, if we approach science teaching and learning to include aspects of cultural intuition, community knowledge, history of place (Bernal, 1998) and pluraversial notions of science (Justice & Tenore, 2017), then we begin to connect the self to the rest of the world bringing about a full consciousness which elicits continuous praxis (Freire, 1970).

It is then as a community of practitioners that we collectively work together to bring about transformational changes that address social injustices writ large. It is our role to present:

> opportunities for students to learn that the relationship between knowledge and power can be emancipatory; that their histories and experiences matter; and that what they say and do counts in their struggle to unlearn dominating privileges, productively reconstruct their relations with others, and transform, when necessary, the world around them. (Giroux, 2008, p. 15)

This challenges Western canonical science since we are now valuing the connection between nature and cultural ways of knowing. By exploring the tensions between science and cultural ways of knowing, we "construct pedagogical approaches that do more than make learning

context-specific; in effect, they need to challenge the content of established canons and expand the range of cultural texts that count as "really useful knowledge" (Giroux, 2008, p. 16-17). In doing so we begin to transform the "world that has largely abandoned egalitarian and democratic impulses" while empowering young people to "challenge authority and resist the notion that education is only training" (Giroux, 2016, p. 57). Thus, the aim of CLESP is nothing short of transforming a hegemonic curriculum into a democratic education.

Chapter II Summary

In this chapter, I explored how disenfranchised Chicanas may reclaim their cultural ways of knowing science through a decolonial curricular approach to science education. I begin this inquiry by asking: What are the testimonios of Chicana preservice teachers and how does this inform their understanding of critical approaches in science education in early childhood classrooms? I use literature that addresses the social injustices of Chicanas subtraction of culture (Valenzuela, 1999), dismissal of their ecology of knowledge (Sousa Santos, 2007), and cultural epistemicide (Paraskeva, 2016) by weaving six dimensions into the CLESP framework. These dimensions include: 1) social justice (Rawls, 1971); 2) Chicana feminist epistemologies (Bernal, 1998); 3) land-based education (Calderón, 2014); 4) critical place-based education (Gruenwald, 2003b); 5) pluralism and cultural sustainability (Mueller & Bentley, 2007; Sousa Santos, 2007); and 6) Paulo Freire's notion of conscientization (Freire, 1970). This literature provides the framework for countering the hegemony and positivistic curriculum that dismisses ways of knowing.

CHAPTER III

METHODOLOGY

This inquiry was situated in the borderlands in the Rio Grande Valley, Aztlan region within one of the largest Hispanic serving institutions; therefore, I utilized testimonio methodology rooted in Chicana Feminist Epistemology (CFE) framework (reviewed in Chapter 2) to highlight how Chicanas' authentic stories empower them as "agents of knowledge" (Reyes & Curry Rodríguez, 2012, p. 527). This methodology was intentional as I used it to counter the Anglophonic tones pervasive in science education academic writing, thereby accentuating a shift towards social justice. I aimed to explore how the testimonios of Chicana preservice teachers had informed critical approaches to science education in early childhood classrooms, especially in Aztlan, Gran Mexico. I drew on narrative inquiry qualitative research methods − oral history and in-depth interviews − in order to produce testimonios related to this theme (Reyes & Curry Rodríguez, 2012). In this chapter, I begin by first reviewing the components of my research and how they relate to one another. After detailing my rationale, I provide relevant details specifying the setting, participants, data collection, and data analysis methods of this project and anticipated directions of discussion.

Research Approach

Qualitative Research

My study emerged from qualitative research. Qualitative research is a broad term to describe a form of research that allows the researcher to study people, events, and natural phenomena. Qualitative research differs from the positivistic mechanisms of quantitative

research in that it provides opportunities where the researcher can study the phenomenon in an uncontrolled natural setting. This means the observed phenomenon is happening in real time without the interference of the researcher (Johnson & Christensen, 2008). This allows the researcher to learn how "individuals experience and interact with their social world, and the meaning it has for them" (Merriam, 2002, p. 5). In doing so the researcher attempts to make sense of the "phenomena through the participant's perspective" (Merriam, 2002). In this regard, qualitative research explores in depth perspective into sociological phenomena as it allows gathering various points of data from observing natural phenomena, "interviews, transcripts, fieldnotes, documents, artifacts, photographs, video recordings and internet sites that documents human experiences about others social action and reflexive states" (Saldaña, 2011, p. 10). This type of data collection allows the researcher to elaborate on the phenomena through "rich thick descriptions". These rich descriptions "provide detailed knowledge of how people feel, think, imagine, and perceive their world" (Geertz, 1973, as cited in Kharel, 2015). The rich descriptions in qualitative research provide the opportunity to view data through various lenses which may otherwise have been stifled if the data were quantified. Qualitative inquiry was necessary to my inquiry as qualitative research explores people, culture, and phenomena that have otherwise been stifled through quantitative data. However, since I have focused on Chicana preservice teachers and their stories in early science education, I branched out into the facet of qualitative research known as narrative inquiry.

Narrative Inquiry

The use of narrative inquiry peers behind the ominous curtain of hegemony and scrutinizes how the positivistic mechanisms that oppress cultural ways of knowing and doing

science may impact Chicana women. In the section below, I discuss how the use of narrative inquiry in this study contextualizes place, culture, and the voice of the marginalized.

Narrative inquiry is a methodology that describes the experiences of the participants through storytelling. This approach amplifies the participant's voice and gives the opportunity to view the data from the participant's perspective:

> Narrative research is an interdisciplinary qualitative research approach that relies on stories told by individuals-the lives of individuals as told through their own stories in social and historical context, narrative is understood as a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected. (Berry & Bowers Cook, 2018, p. 87)

In addition, narrative inquiry is unique in that it could render a type of qualitative research that has an artistic quality which values stories (Kim, 2016). This type of "storytelling" adds an artistic quality that allows qualitative research to yield a different "interpretive paradigm that uses words rather than numbers in its analyses and focuses on understanding human action through interpretation rather than prediction and control" (Kim, 2016, p. 5). Narrative inquiry is also essential in understanding cultural phenomena and community building since cultural ways of knowing (i.e., indigenous knowledge) is passed down from one generation to the next through stories.

> It is a commonplace to note that human beings both live and tell stories about their living. These lived and told stories and talk about those stories are ways we create meaning in our lives as well

> as ways we enlist each other's help in building our lives and communities. (Clandinin, 2006, p. 44)

This type of inquiry allows the researcher more freedom to explore and articulate other facets of phenomenon that have otherwise been impeded by traditional research. Traditional research stifles the relationship between researcher and participant as traditional research requires a more rigid set of parameters that are grounded in positivist approaches. Thus, the traditional research process often is more formulaic in design and narrow in scope. In contrast, "narrative research necessitates a relationship between the researcher and the participant more akin to a close friendship, where trust is a critical attribute" (Mills & Gay, 2019, p. 354). This allows the researcher to build a rapport that enables both the researcher and the participant to be free from "this restrictive pattern too often found in academic texts and discourses" (Chavez, 2012, p. 335). Such discourses often render the author's knowledge and identity as inconsequential, muting identity and divorcing knowledge from its cultural contexts. To the contrary, the value of storytelling allows the researcher to "reflect on the narrative anchor of human identity, observing that each of us constructs and lives a narrative and that this narrative is us, our identities" (Eakin, 2008, p. 1). Moreover, authors can use these stories to give voice to the underprivileged – not to mention their own intersectional identities – in a manner that is so often bred out of traditional academic writing (Mills & Gay, 2019). Although narrative inquiry provides freedom and openness, I turned towards testimonio, as it specifically highlights the voices of resistance to dominant narratives in a first-person perspective.

Testimonio

Testimonios are a traditional form of traditional Latin American narrative that highlights the sense of urgency for change in "dominant ideologies of meritocracy, individualism and

color-blindness [that] mask the complex struggles of Students of Color and the systems of oppression that creates the conditions for those struggles" (Huber, 2009). Although testimonio is considered a critical form of narrative, testimonio is its own independent genre of research.

In the U.S., testimonio is considered a research methodology that "combats and counters Eurocentric methodologies and provides a decolonizing methodology designed to produce differently oriented and critical human science representations" (Jupp et al., 2018, p. 22). This form of narrative "pushes Statesian and Anglophone bounds" (Jupp et al., 2018, p. 22) that are pervasive in academic contexts and scholarship as it "departs from the Eurocentricity of traditional educational research, guided by an anti-racist and anti-hierarchical agenda" (Huber, 2009, p. 644). In this regard, testimonio brings the reader in to participate and engage in understanding the silencing, oppressive forces, as well as the conflicting identities of the narrator. Thus, testimonios amplify the voice of the oppressed as well the authors own intersectional identities. This openness elicits the space of bringing Chicana preservice teachers' voices to foreground. In the section below, I elaborate on testimonio as a methodology and describe the rationale of using testimonio in my inquiry.

Testimonio as Methodology. Before discussing the testimonio as a methodology, I discuss the "political purpose" (Bernal, Burciaga, & Flores Carmona, 2012, p. 363) of testimonio by first contrasting it to the narratives told by others, such as the media. Consider a typical news report where you see a reporter discussing poverty, war, politics, brutality, or disease. These stories are reported in such a way that serves only to generally inform the masses and drive the dominant narrative. The audience is set in the role of the outsiders looking in. What you do not see or hear is how the actual people are affected by war, poverty, disease, violence, and politics. How do those people bring their voice forward to inform you about the "real" story?

For centuries people have used a form of storytelling to inform others about their life and experiences with such social political injustices. In Latin America, this form of narrative is called testimonio. Testimonio is a powerful form of narrative that “exposes brutality, disrupts silencing, and builds solidarity among women of color" (Anzaldúa, 1990, as cited in Bernal et al., 2012). Testimonio provides the storyteller an opportunity to bring their voice forward and share their own personal experiences (Bernal et al.). In this regard, testimonio links:

> the spoken word to social action and privileges the oral narrative of personal experience as a source of knowledge, empowerment, and political strategy for claiming rights and bringing about social change (Benmayor, Torruellas, & Juarbe, 1997, as cited in Bernal et al., 2012, p. 153).

This social change begins with critical awareness within our own communities. In this respect, testimonio draws attention to the ways of knowing and learning within our communities (Bernal et al.) whilst critically reflecting on changes that may improve life for those affected by socio political injustices.

Scholars utilize testimonio as a methodological tool to “bridge and connect the lived experience as a data collecting tool and analytical process” (Bernal et al., 2012, p. 365). Testimonio aims to provide scholars with an in-depth look within the lived experiences of Chicana’s lives. In “the field of education, scholars are increasingly taking up testimonio as a pedagogical, methodological, and activist approach to social justice that transgresses traditional paradigms in academia” (Bernal et al., 2012). It may shift the paradigms within education as it may challenge the apartheid of knowledge that stems from Eurocentric epistemologies that “devalue knowledge and belief systems of those who do not share the same perspective” (Huber,

2010, p. 83). It also shakes up the Eurocentric epistemologies by drawing the reader or listener into the narrator's journey provoking a form of conscientization. This new sense of conscientization forms a bridge between the narrator's experience with social injustices by connecting with the listener or reader through a sense of solidarity. It is through the "sense of solidarity" that testimonio can serve to help articulate the social justice issues that are pervasive in educational settings, especially in the Chicana population.

Thus, I used testimonio in this vein as a methodology with the specific intention of bringing our Chicana preservice teachers voices forward. In doing so, I hoped to empower them while providing a space to reflect to understand themselves first (Berry, 2010). By understanding themselves first and critically reflecting on their identity and privilege, we provided spaces that nurture agency, thus eliciting reflection which then promoted conscientization in both the author and the participants (Freire, 1970; Chungara, Ortiz, & Viezzer, 1978; Menchu, 2010). This form of critical consciousness is especially important within teacher preparation programs. Teacher preparation programs build the foundational approaches of how we view teaching science and "doing science". Hence, if we foster a state of agency that pushes towards conscientizing Chicanx teachers, we build toward systemic change.

Rationale

Drawing from my own experience in science education as stated in Chapter 1, I chose testimonio as my method of inquiry because it "validates my Chicana presence as well as draws attention to my marginal position inside dominant structures"of science education (Chavez, 2012, p. 2). The dominant structures of science's structural edifices are rooted in patriarchal foundations of Western Eurocentric sciences. This patriarchal structure is seen throughout academic culture where most STEM professors and professionals are "white, male, and middle

class" (Cantú, 2012). In addition to the prominent gender biases and sexism in STEM fields (Martin & Fisher-Ari, 2021; Martinez & Christnacht, 2021), the dominant structures within Eurocentric science have continuously dismissed indigenous ways of knowing. Consequently, the lack of cultural connections to science may impact Chicanx students. This is essential to recognize because the present science curriculum lacks cultural connections in science education; this gap may cause Latinx students to feel invisible and disenfranchised (Nouri et al., 2020). Thus, if we want our Chicanx students to feel seen, heard, and connected to science, we must bring Chicanx voices forward to share their own experiences with social injustices in science education. In doing so, we empowered Chicana Preservice teachers to reflect and consider critical pedagogical shifts that liberate their students from the same structural oppression they endured. In this shift, the oppressed become liberated (Freire, 1970), bringing forth a democratic learning process where "doing science" is synonymous with cultural ways of knowing (Sousa Santos, 2009). By acknowledging our cultural ways of knowing we begin to reclaim our culture, language, and history, thereby dismantling the assimilation and epistemicide of our Chicanx heritage (Paraskeva, 2016).

Thus, testimonio is appropriate for my inquiry as it is used with the specific intention of highlighting how preservice teachers can utilize testimonio to elicit an open critical dialogue that shifts towards discussions of plurality and critical consciousness within teacher preparation programs. Critical consciousness within teacher preparation programs is essential as it contributes to systemic changes. These changes create a paradigm shift toward using a broad array of criticalities which can reconceptualize the way we approach teaching science.

Research Design

Research Setting

This study took place in the RGV Aztlan region, at a Hispanic Serving institution with a 92% enrollment of Latinx students, one of the highest in the nation (Excelencia in Education, 2020). The University of Texas Rio Grande Valley (UTRGV) is located deep in South Texas in what is historically considered the Aztlan region. This region extends from Tamaulipas and through South Texas's contiguous counties Cameron, Hidalgo, Staarr and Willacy County as well as through Laredo, Victoria and Corpus Christi. The population of Rio Grande Valley is primarily Latinx and primarily bilingual. Although this area is considered one of the poorest areas in the nation, its people are rich in culture and linguistic heritage. According to UTRGV's *Institutional Summary 2021-2022*, 90.8% of enrolled students identify as Latinx. Currently, UTRGV has an undergraduate enrollment of 84.1%, of which 60.2% are female.

Selection of Participants

Since my research is centered on examining preservice Chicana/Latinx's teachers at UTRGV, I utilized a purposive approach to sampling. I utilized this sampling technique in order to select participants who shared necessary, predetermined characteristics. All four selected participants were currently enrolled at UTRGV in the teacher preparation program and identified as Chicana/Latinx. All four participants also had some cultural experience with ethnobotany in their lives. This was essential to my inquiry as I was examining the tensions between cultural indigenous knowledge and early childhood experiences in science, specifically within the Chicana/Latinx population.

Data Collection

During the data collection and analysis process, the four participants selected went through a series of three steps (Figure 2): 1) Convergence of Participant Testimonios and Elder Interviews; 2) Collective Testimonio Focus Group 1; and 3) Collective Testimonio Focus Group 2 (Huber, 2009). Each part of the data collection process builds towards the overall analysis, with data collection and analysis at each step informing the rest of the process (Huber, 2009).

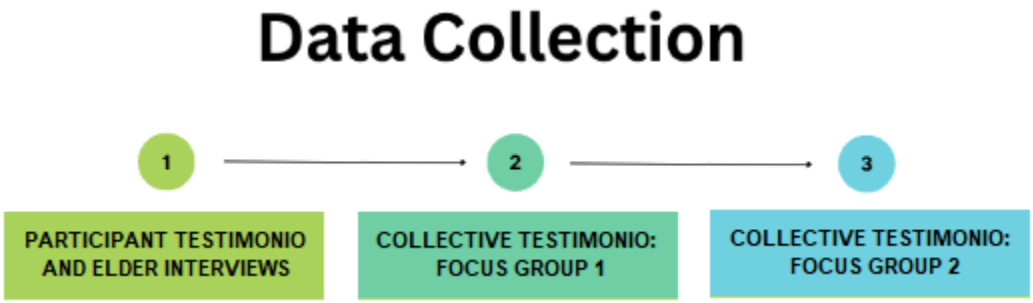

Figure 2: Phases of Data Collection

The outline of my process is as follows. During the first step, participants individually provided their own testimonios and then performed two separate semi-structured interviews with their own family elders. These testimonios and interview transcripts were collected, analyzed and reviewed. For the second step, named Collective Focus Group 1, I met with the participants as a group in a roundtable discussion format informed by the data they collected and produced in the elder interviews. For the third step, named Collective Focus Group 2, I posed the last series of prompts and participants identified themes of the data they collected, either agreeing or disagreeing based on their own experiences.

Part 1: Convergence of Participant Testimonios and Elder Interviews. Participants were asked to provide a written testimonio regarding their experience in native language, educational science classroom experience, home support to learn science, cultural traditions,

cultural indigenous practices, historical identities within their own families, and knowledge of native plants. After providing testimonio of their own experiences, participants conducted semi-structured testimonio interviews with their elders using the same prompts from their testimonio assignment. Interviews were conducted with the eldest man in their family and with the eldest woman in their family. These were formatted as semi-structured interviews to better encourage casual conversation to occur. Participants were required to record the interviews, and I transcribed the interviews to ensure the accuracy of the transcriptions used in this study.

After interviewing their elders, the participants wrote reflections based on their elders' responses. The participants submitted both their initial testimonios and their elder reflections, and I analyzed, coded, and identified themes. I then used the insights from these testimonio, interviews, and reflections to create writing prompts that were used in the collaborative process roundtable discussion in Part 2 to promote discussion connecting what they learned from their elders to their own practices teaching sciences to Chicana/Latina elementary school children.

Part 2: Collective Testimonio - Focus Group 1. In this step, I used the writing prompts created in Part 1 to facilitate a roundtable discussion among the four participants. The participants were each given one writing prompt and given time to write their own responses to the prompt they were given. The participants took turns reading their written responses, then engaged in active discussion about the common themes they would use to organize this data. The discussion was recorded, transcribed, analyzed, and coded.

Part 3: Collective Testimonio - Focus Group 2. After participants discussed common themes, I posed the last series of prompts that asked the participants to 1) discuss what they can do to leverage elders' ways of knowing into their practice, and 2) discuss how the interviews, discussions, and common themes inform their practice. Participants again took turns responding

to these prompts. After the themes were identified within this group, the participants then discussed as a group how they should be categorized by agreeing or disagreeing based on their own lived experiences (Huber, 2009). This process fostered opportunities to engage in dialogue that connected the participants to their own experiences and "theorize explanations for the racism, nativism, sexism, and classism they experienced throughout their educational trajectories" (Huber, 2009, p. 647). The roundtable discussion was recorded. I transcribed the discussion, noting my own observations in my field notebook.

Data Analysis

For the participant testimonio and elder interview phase, I transcribed and analyzed the interviews and reflections using a critical race grounded theory approach (Malagón, Huber, & Velez, 2009). This approach allows the researcher to engage in "flexible and various sources of knowledge by collecting and analyzing qualitative data to construct theories grounded in the data itself" (Malagón et al., 2009, p. 266). I identified emerging themes that were used to create writing prompts for the Collective Testimonio Focus Group 1 roundtable discussion. The purpose of this first step was to promote discussion connecting their experiences and their elders' experiences to their own practices teaching sciences to Chicana/Latina elementary school children.

For the Collective Testimonio - Focus Group 1 phase, I gave one writing prompt that was previously developed using themes from their elder interviews and reflections. The participants were given time to write their own responses to the prompt they were given. The participants took turns reading their written reflections, then engaged in active discussion about the common themes they would use to organize this data. The discussion was tape recorded and later transcribed and coded.

For the Collective Testimonio - Focus Group 2 phase, I used a tape recorder to capture the discussion of the participants as they answered the series of prompts that asked the participants to 1) discuss what they can do to leverage elders' ways of knowing into their practice, and 2) discuss how the interviews, discussions, and common themes inform their practice. Participants took turns responding to these prompts. After the themes were identified within this group, the participants then discussed as a group how they should be categorized based on their own lived experiences. This discussion was transcribed, analyzed, and coded.

The purpose of the testimonio focus groups 1 and 2 was for Chicana Preservice Teachers to identify patterns through their own experiences in early science education, cultural practices, and historical identities within their own families. My aim was that these shared experiences elicit a "sense of solidarity". According to Huber (2010), this sense of solidarity can offer Chicana/Latina a seat at the proverbial table by providing a way to center the experiential "knowledge of people of color, by recognizing the power of collective memory and knowledge, that guides the larger goals of transformation and empowerment for Communities of Color" (p. 83).

Following the three phases of collection, I synthesized all the combined findings and insights gathered, including all elder interview transcripts, reflections, discussion insights, field notes, and the recordings from the collective testimonio 1 and 2. All recordings from the discussions were transcribed, analyzed, and coded. I used these codes to categorize themes. Finally, these themes were analyzed by utilizing concept mapping to "explore the relationships between categories and develop analytical codes that led to identifying larger theoretical connections" (Huber, 2009, p. 648). I then analyzed the data with particular emphasis on how these data could be used to inform Chicana Preservice teachers' approach to science education.

The three combined phases of this analysis may advance the Chicana feminist epistemology framework in that this data collection process was co-constructed by the participants and their cultural intuition (Huber, 2009). Furthermore, this methodology may advance Chicana feminist epistemology as it aims to acknowledge Chicana ways of knowing, thereby challenging the apartheid of knowledge that stems from Eurocentric epistemologies that "devalue knowledge and belief systems of those who do not share the same perspective" (Huber, 2010, p. 83). This was paramount in this study as it adds to the value of critical conscientization, the study's overarching goal.

Chapter III Summary

In this section, I discussed the use of testimonio as my methodology. I intentionally used this to counter the Anglophonic tones pervasive in science education academic writing. I explored how the testimonios of Chicana preservice teachers inform their understanding of critical approaches in science education in early childhood classrooms. I introduced my methodology by first providing an overview of qualitative research, then focusing on narrative inquiry through a feminist epistemological lens as the methodological cornerstone of this project. I then discussed how testimonio highlights how Chicanas' authentic stories and can help empowers them as "agents of knowledge". After detailing my rationale, I provided relevant details specifying the setting, participants, data collection, and data analysis methods of this project.

CHAPTER IV

CHICANA PERSPECTIVES ON SCIENCE EDUCATION

In this Chapter, I examine the data and themes that emerged from the research question: What are the testimonios of Chicana pre-service teachers and how does this inform their understanding of critical approaches in science education in early childhood classrooms? In Figure 3 below, the graph provides context for my findings. To this end, I first introduce the participants and their elders through the lens of their respective testimonios. As these transgenerational testimonios unfold and converge, patterns of systemic oppression, lack of equitable teaching practices, and lack of cultural connections in science education emerge. These converging patterns were utilized to formulate the questions for focus group 1. The responses from focus group 1 led to reflective analysis and critical conversations about injustices in bilingual education, community wealth, and what counts as science. These critical conversations were discussed in focus group 2. Details of these conversations and its emerging themes will be reported in this chapter, and broader discussion of the greater implications of these conversations will be addressed in Chapter V.

Testimonios de los Participantes

In this section, I will introduce you to the participants by sharing key components of their provided testimonios. These testimonios invite you to intimately view a complex well of identity that encompasses pain, shame, hope, and, ultimately, pride of their cultural identities. As you read them, note the similarities between key lived experiences related to language prohibition, inner conflict within bilingual education, pride of cultural knowledge, and connection with

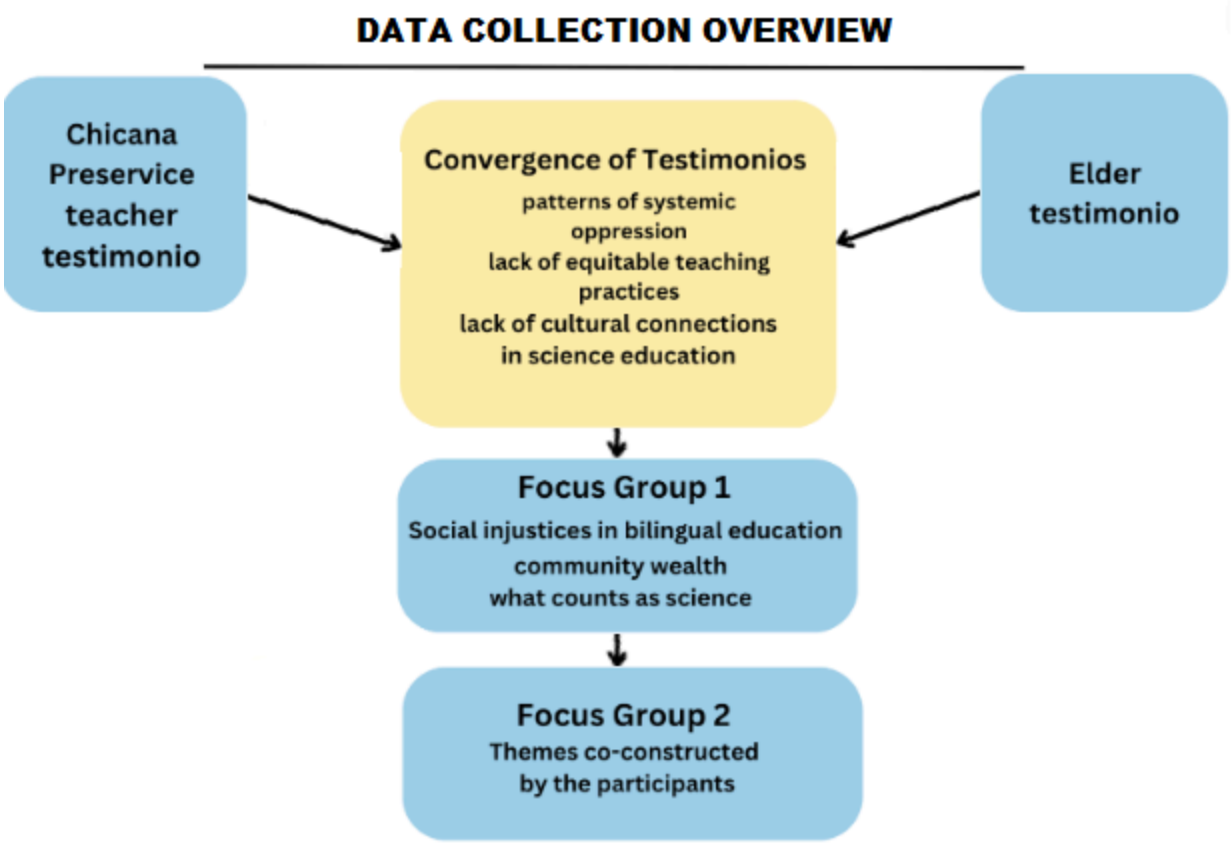

Figure 3: Data Collection Overview

community. These autobiographical portraits and testimonios were collected during the first part of the elder assignment. The four participants were assigned pseudonyms to protect their identity. "Alex", "Raquel", "Karolina", and "Clara" share in common that all four of them are Chicana preservice teachers who call the Rio Grande Valley their home.

Alex (they/them/theirs) – "I Am a Fortunate Bilingual"

Alex was born and raised in the Rio Grande Valley. Alex's family are immigrants and their native language is Spanish. Although they mention that they are proud of their culture and heritage, they felt very conflicted with their identity. Alex recalls how they initially felt about speaking Spanish when they first started elementary school. Alex felt conflicted because everyone spoke English and their school did not provide an environment that embraces other

cultures or languages. Alex felt ashamed of speaking Spanish. Alex admits that they tried to assimilate because they did not want to feel different than everyone else in school:

> Despite my first language being Spanish, I would like to say that I am very fortunate that I am a bilingual individual. After speaking Spanish for about 4 years, English is all I learned and spoke a majority of my time because of school. I was honestly very embarrassed to speak Spanish at school, so my biggest mission in elementary school was to learn English as fast as I could. (Elder Assignment, Part 1, p. 15)

The school's monolinguistic climate and submersion curriculum further impacted Alex's feelings of otherness and alienation so much so that they even began isolating themselves from their own family. Despite the fact that Alex's parents only spoke Spanish, Alex continued to speak English even at home, which caused a degree of separation between them and their parents:

> I would always get sad and I wanted to learn English so bad. Because I wanted to learn English so badly, I had this — not hatred — but I resented Spanish for a long time, so when I would go home, I would just speak in English. Mind you, my parents only speak Spanish, so I created this language barrier between me and my parents. (Focus Group 2, p. 2)

Although Alex was labeled as an ESL student and faced internal conflict about their native language and culture, they continued striving to learn. Alex states that all of their schoolwork was in English, which caused further disconnect at home since Alex's parents only spoke Spanish. Despite being very supportive of Alex's endeavors in school, they were often

unable to help because of the language barriers. However, Alex did manage to get assistance from an older brother: “I was lucky enough to have an older sibling to be my guide and helper with my schoolwork” (Elder Assignment, Part 1, p. 15). Alex felt fortunate to have their brother's and their family’s support, even when that support was predominantly in an emotional rather than a practical context.

Alex expressed that they were blessed because they experienced a rich cultural upbringing. Alex fondly recalls dichos and the traditions of their family such as remedios caseros. Alex proudly states that they felt very fortunate because their family passed down cultural knowledge about different experiences with plants and animals:

> Another fact about me is that I am very knowledgeable about the names of the plants because my parents have a green thumb and I have been exposed to so much nature growing up gardening with them, raising chickens, ducks, etc. (Elder Assignment, Part 1, p. 1)

Despite having inner conflict about their early experiences in school, Alex is proud of their culture, heritage, and traditions. Alex recognizes the value of their cultural knowledge and wears it as a badge of honor. Alex’s autobiographical narrative draws attention to the systemic injustices prominent in bilingual education. Alex also prominently emphasizes their experience with nature and cultural knowledge.

Raquel (She/Her/Hers) - “El Que Se Fue Para La Villa Perdió Su Silla”

Raquel considers herself to be a migrant and although she was not a Rio Grande Valley native, she calls the Rio Grande Valley home. Raquel’s native language is Spanish and she is bilingual. Although Raquel knew both languages well, she recalls that she felt othered in her formative elementary years. She attributed the feeling of otherness to being in a different culture

from her own. She lived “up north” and although there was a lot of diversity in the area in which she lived, she still felt like an outsider: “I have first-hand experience of different cultures, but also feeling like an outcast” (Elder Assignment, Part 1, p. 8).

Raquel mentions that, in the school up north, she did not want to speak Spanish; she felt that speaking Spanish carried a negative connotation. She attributed this to the political rhetoric that has been circulating for centuries now. Raquel postulates that rhetoric and xenophobia may have implications towards embracing multicultural approaches in the classroom:

> I feel like right now there's always talk about immigrants coming into the United States and it's seen as a bad thing. People don't want them to come over here. I feel like that's why they encourage English to be used because there shouldn't be people from other places here. It should just be only Americans and stuff like that. I feel like that's another reason why teachers steer away from learning the different languages and try to have a multilingual classroom and stuff like that. I feel like that's like a social injustice that is seen a lot. (Focus Group 2, p. 25)

Raquel mentioned that perhaps these political influences may have made her feel like she didn’t belong in spaces up north. She said that up north there were many “conservative” but liberal ideologies. Although there was a rich diversity of different nationalities in the area where she lived, Raquel felt like she could not relate to the people around her:

> Over there, I always felt out of place because it's very conservative but liberal at the same time. I always felt like, "I don't belong here." I always felt like what they talked about wasn't related to my

> experiences. Once I came down here, this is where everything was taught more to our community because we're all the same. Over there, there's more students of different ethnicities, and there's a lot of diversity over there. I always felt out of place, and down here, I never felt like that. (Focus Group 2, p. 17)

Along with the rhetoric of the political climate, Raquel's sense of belonging was challenged by her being uprooted from place to place. She reflects how it felt when she moved around and said it was sometimes difficult as she had to leave behind a community, family, and friends: "Being a migrant, switching between schools during the school year could be difficult since we left behind new friends, teachers, and communities we became a part of" (Elder Assignment, Part 1, p.8). Although Raquel found these particular times challenging, she very much appreciates the experiences that being a part of a migrant family afforded her. She states that she got to experience different seasonal experiences and truly enjoys the diversity of nature. Raquel also mentions that being part of a migrant family allowed her the opportunity to experience being surrounded by different cultural values and languages:

> Living up north offered a different natural setting than the Rio Grande Valley does, we were able to experience the true change in seasons, such as the leaves changing color and as well as many other cultures that differed from the Valley's. (Elder Assignment, Part 2, p. 8)

Raquel's closeness to her family is also evident in that she mentions that they supported her efforts in school and they also shared their knowledge of dichos y remedios caseros with her. She states that she is fascinated with the origin of dichos and her family's ancestral knowledge:

“I also got to learn more about home remedies and ‘dichos’ that have been in my family for generations and it was very interesting” (Elder Assignment, p. 9). Raquel’s experiences highlight the lack of multicultural education, which also relates to the systemic injustices prominent in bilingual education. Raquel’s account also frames her sense of connection to nature in the context of her cultural values.

Karolina (She/Her/Hers) - “El Tiempo Lo Cura Todo”

Karolina is a Rio Grande Valley native. She states that her native language is English but that she is bilingual. She states that she had family support learning Science and Math as her family spoke English and had a formal education. Her experiences in science were reinforced by her parents, who were educators. She states that she has spent a lot of time outdoors and she really is interested in learning more about astronomy. However, despite the advantages of having family support and economical privileges, she still felt shy as a result of discrimination based on her skin color. She reports that even though English was her first language, people often assumed that she spoke Spanish because she was “morenita” — darker complexion:

> Growing up, I have always been a shy person who wouldn’t make friends very easily. There was one instance that I remember being in 3rd grade and feeling as if I didn’t belong amongst a group of kids at my tennis camp in the summer. All the students were lighter-complected and only spoke English, while I was darker-complected and spoke both English and Spanish. I clearly remember the students expressing that I spoke Spanish and we couldn’t communicate, little did they know my dominant language was English just like them. Looking back now, I am able to realize

> that these kids placed a stereotype on me because of my color and were ready to exclude me from being in their group. (Elder Assignment, Part 1, p. 3)

Karolina expresses regret that people are still treated this way despite the advances we have made as a society and in bilingual education. She feels that it is unjust that people are discriminated against just because of the color of their skin: "Many people still go through this, and it is sad to think about it because of how far we have come from back then" (Elder Assignment, Part 1, p. 3).

Karolina is optimistic that perhaps time will change the way people are treated, a value she learned from her grandmother. She states that her grandmother taught her different "dichos", or adages, that she keeps close to her heart, forming a mantra which she lives by: "One that has stuck with me was told by one of my grandmas. She told me, 'El tiempo lo cura todo,' or, 'Time heals everything,' and I have lived by that every day" (Elder Assignment, Part 1, p. 3). Karolina believes time will heal everything and she hopes that eventually people will respect other people despite the differences in the color of their skin or because of the language they speak: "Hopefully, in time, no other student has to go through what we have gone through, and do not feel belittled because of their skin color or the language they speak" (Elder Assignment, Part 1, p. 3).

Karolina's autobiographical narrative draws attention to her experiences with discrimination and implicates the systemic injustices prominent in bilingual education. Along with Alex and Raquel, she also discusses her experiences with nature and the greater cultural context in which they occurred.

Clara (She/Her/Hers) - "Science Comes Natural to Me"

Clara is a Rio Grande Valley native. Her native language is English but she considers herself bilingual. She recalls fond memories of her early experiences in the science classroom. She states that she never needed additional help in science because she felt a natural affinity towards it. She attributes this excitement towards science to having a lot of hands-on experiences that made learning more concrete for her as opposed to her experiences in math:

> I also recall experiencing science in a fun way, especially in elementary school, when I made models out of clay, edible food, colors, construction paper, and other materials. It was a subject that I recall being really hands-on and requiring a lot of inventiveness. (Elder Assignment, Part 1, pg. 8)

In addition to the hands-on experiences she had in her science classroom, she also attributes her love for science because her family also utilized outside community resources such as parks and butterfly centers to emphasize her understanding in science by direct experience with the environment around her: "My parents were always willing to take us to educational locations in the community, such as the parks, zoos, and butterfly centers" (Elder Assignment, Part 1, p. 2). In addition, Clara's love for science may also be attributed to her spending time in nature. She fondly recalls experiences where she spent time exploring her own backyard "for hours". She states that she spent a lot of time exploring and learning about different animals, insects, and plants. She shares fond memories of learning how to grow her own plants from a gardening kit:

> Some experiences exploring nature as a child would be going to the zoo or aquarium. I remember learning and seeing all the

> different animals, insects, and plants. We constantly get a variety of insects because we have a decently big yard with some orchards, trees, and flowers, and my favorite insects to look for are lady bugs, so I would spend hours hunting for different ladybugs. There's also a distinct memory I had as a child of my parents buying my own children's gardening kit, which came with various tools and seeds, and I remember spending time outside digging holes to plant the seeds and watching the process as they grew. (Elder Assignment, Part 1, p. 2)

Because of these early childhood experiences with the community and nature, Clara states that to this day as an adult she seeks these experiences on her own. She mentions that she likes to attend community events that emphasize learning about science because that is how she experienced learning science in her childhood:

> I recall around two years ago they had an event where they had live animals such as reptiles and insects on exhibit, as well as many fossils, rocks, and historical artifacts for people to acquire knowledge and look at. (Elder Assignment, Part 1, p. 2)

Although Clara has positive experiences in her early elementary science classrooms, she mentions that other friends in the same classroom did not have the same experience. Clara states that all of the lessons in her science classroom were taught in English. She recalls that when other students tried to ask questions in Spanish, they were not permitted to speak Spanish:

> I do recall students who spoke Spanish as their first language not being permitted to speak Spanish in the classroom. Most of these

> students had trouble learning English. I remember this particularly because I witnessed them not receiving assistance when they asked the teacher. (Elder Assignment, Part 1, p. 3)

She also mentions that because these students were not permitted to use their native language in the class, she observed that they started to "act out" in class because they did not understand. Furthermore, she did not observe the teacher trying to assist them in understanding the material:

> Many of them felt embarrassed and excluded from classroom activities. For instance, I still recall a student who spent the majority of class time confused. As a result, this student began to act out and was perceived as an individual who didn't care about school, but in reality, this was because of the lack of attention and assistance to help him better understand the material. (Elder Assignment, Part 1, p. 4)

Clara's historical portrait reveals her experiences with learning science as something that was ingrained within her family experience. Although she did not report experiencing any particular challenges in school, she does recall discrimination other students faced as a result of being isolated from instruction due to teachers speaking English exclusively and failing to appropriately help students who only spoke Spanish.

Testimonios de los Mayores de la Comunidad

After providing testimonio of their own experiences, participants conducted testimonio interviews with their elders, asking the elders the same questions they initially answered about their native language, educational science classroom experience, home support to learn science, cultural traditions, cultural indigenous practices, historical identities within their own families,

and knowledge of native plants. The participants then compared their initial responses with that of their elders' responses during a portion of this assignment. The participants identified common elements between their own testimonios and those of their elders, identifying transgenerational experiences with oppression of language, lack of bilingual resources, and a shared wealth of cultural knowledge. These will be discussed in the subsequent paragraphs below. The elders will be introduced in the same order as the participants were in the previous section: 1) Alex's elders, 2) Raquel's elders, 3) Karolina's elders, and 4) Clara's elders.

Alex interviewed one male elder and one female elder. Alex mentions that both of their elders "were like me" in that their Native language was also Spanish. Alex also mentioned that both elders were immigrants and received their education in English and not their native language. Furthermore, Alex mentions that both they and their elders did not have support at home with respect to their education:

> I was able to compare and contrast our early childhood experiences, cultural traditions, knowledge about nature, and even the advantages and disadvantages we had in our lives, such as not having support or having enough support for extra help in our school work. (Elder Assignment, Part 2, p. 15)

Alex also shares that both elders have experience in home remedies, dichos, and knowledge of plants. Alex shares that another difference they noted was that both of their elders experienced nature through labor as opposed to the way Alex experienced nature: "Something else that did stand out to me was that my elders experienced nature as a child doing manual labor outside in the wildlife" (Elder Assignment, Part 2, p. 17). Alex shares their appreciation for their elders' knowledge and hardwork. Alex states that they were "fortunate" because they did not have to

participate in manual labor during their formative years in school: “I was fortunate to go on educated field trips to learn about wildlife and organisms in our ecosystem and was fortunate enough to not be exposed to nature only by working” (Elder Assignment, Part 2, p. 17). Alex states that they feel proud of their family and acknowledges the sacrifices they have made.

Raquel interviewed one female elder and one male elder. In her interview assignment, she mentions that both of her elders were immigrants and their native language is Spanish. She says that both elders have experience with home remedies, dichos, and knowledge of plants. In her reflection, she found more items in common with the male elder than the female elder. She states that her experience in school was similar to the male elders' experience because he also attended school up north like she did and was also a migrant worker: “We both attended school up north and had somewhat of the same experience; he and I were both migrants” (Elder Assignment, Part 2, p. 8). Raquel also mentioned that another difference is that the female elder did not have support at home to learn math or science. She stated that the female elder did not have access to community resources because she lived on the ranch; however, Raquel states that the elder woman “did have a lot of knowledge of animals and plants because of her experiences living on the ranch” (Elder Assignment, Part 2, p. 8).

Karolina interviewed one elderly woman and one elderly man. Both of her interviewees were natives to the Rio Grande Valley. Karolina reports that both of the elders claim English as their native language. Karolina stated that the both elders did not have any community support to help them learn Science. Also, Karolina reported that her female elder did not have any support at home to assist with her homework because her elder was the support for the rest of the family. Karolina mentions that one of the biggest noticeable differences between her science experience and that of the elder female is that the elder female stated that most of her elder’s science

experiences came out of a textbook: “One thing my elder mentioned that stood out to me was that when she was learning science and math in the classroom, it was mostly textbook-based with little hands-on activities” (Elder Assignment, Part 2, p. 8). She notes that although both elders spoke English, they still lacked the support they needed to assist them in learning more science and math. However, she is still very proud of her family and glad she had the opportunity to learn about them more.

Clara interviewed an elderly woman and an elderly man. Clara states that both of the elders are native Spanish speakers but they consider themselves bilingual . The elder man was from Texas and the elder woman was an immigrant. Clara reported that both elders knew a lot about nature, home remedies, and care of animals as they lived on a ranch. Clara also stated that both of her elders did not have support to learn science at school or the community, so they asked their own brothers and sisters to assist them with school work:

> I recognize the distinction between his and mine. For starters, they didn't have the community's support when it came to math and science because they didn't live in town; they lived on a ranch. He got all of his extra educational knowledge from his siblings and parents after school; he didn't participate in any after-school activities or events that would assist him to enhance his knowledge outside of the school system. (Elder Assignment, Part 2, p. 10)

Clara recognizes the value of her elders' knowledge as she states “even though they had limited resources in certain circumstances, they used what they had to learn at home or at school” (Elder Assignment, Part 2, p. 10). Clara is also proud of her family and states that she appreciated getting to know more about their educational background.

The Transgenerational Chicana Experience in Science Education

In summary, the transgenerational collective experiences of both the participants and the elders led to common patterns. Among the common patterns were systemic oppression. Both participants and their respective elders reported prohibition of their use of native language and lack of support in their native language for learning the content. In addition both participants and their respective elders also reported lack of equitable teaching practices. This corresponded to the lack of resources, language support in the classroom which included being ignored. In addition, both participants and their respective elders mentioned that there was a lack of cultural connections in science education. Although the participants and the elders had rich history in cultural knowledge this was not utilized in the classroom. Learning for them was decontextualized through textbooks and worksheets.

Emerging Themes: The Convergence of Testimonios and Reflexiones

Following their elder interviews, the participants had some time to process what they learned from their elders before being asked to provide reflexiones on how the interviews with their elders informed their future practice as teachers. All of the participants responded with ideas of future practices that they may utilize in their classrooms with the consideration that the children in their classroom may have elders at home that may assist the elementary school children with their assignments. In the paragraphs below, I will elaborate on each of the participants' testimonios and elder reflexións, providing context for how this assignment informed the subsequent focus groups.

Alex reflected on his own experiences and compared them to his elders' experiences. Both Alex and their elders were both taught in English. Both Alex and their elders did not have the support at home to learn science except for their siblings. Alex considers these experiences

and makes the informed decision to consider children that may be in the same circumstance in their future classroom:

> So, I can take into consideration that not all students have the same support at home as my elder and I did. We were lucky to have siblings to help us out and she was lucky to have parents to help her as well. When I was growing up, I knew that a bunch of students were also in my shoes, such as not having a parent who was fluent in English or had a proper education. With this, I would like to send homework, instructions, or newsletters in Spanish and English so parents are aware of what is happening in class and can assist their children. As a future bilingual educator, it will be my job to adapt my lessons and content for my students and to communicate effectively with their parents/guardians. (Elder Assignment, Part 2, p. 15)

Alex's reflection on their generational adversity has brought forward some initial considerations. Alex mentions their new perspective when teaching a classroom of a diverse population of students has shifted after speaking to their elders. Alex now takes into consideration the cultural knowledge that students may carry into the classroom. "My outlook in life has shifted and has made me more aware of the knowledge some caregivers hold and pass down to students outside of the classroom" (Elder Assignment, Part 2, p. 15). Alex now considers both the cultural knowledge students bring into the classroom as well as the necessary support that teachers must provide native Spanish speakers.

Raquel's elder reflexión led her to consider the lack of multicultural responsiveness in the schools that she experienced as well as her elders. She posits that schools need to consider including multicultural approaches in the classroom. She also states that teachers should know where students are from and they support them so that teachers may provide sufficient support:

> In our future classrooms, we will have students with different backgrounds and different cultural beliefs. We as educators need to be informed about where our students come from and what type of support they may or may not be receiving outside of school. (Elder Assignment, Part 2, p. 8)

Raquel further describes that teachers should make all bilingual learners feel included in the classroom. She suggests that teachers can connect to bilingual students by making the lessons relevant to their personal life, thereby igniting their interest in learning. Bilingual learners, in particular, need to know that their education is important to their educators because as children see that the lectures, activities, or readings relate to them, they will feel a more personal connection with the topic and be more interested in it (Elder Assignment, Part 2, p. 8).

Raquel further describes how interacting with her elders provided her the opportunity to consider different perspectives in how the educational system affects others and what changes need to be made in order to address these issues. “I got to expand my knowledge of the education system and how I, as a future educator, can improve education through different perspectives” (Elder Assignment, Part 2, p. 8). Raquel’s reflection considers the implementation of multicultural education, more support for bilingual students, and culturally relevant lessons. Raquel's thoughts about multicultural approaches counters the “inherent monoculturalism” that

reflect power relations and inequalities (May, 1998) that are deeply systemic within educational institutions.

Karolina considered her educational perspectives as well as her elders' experiences. She concluded that the perhaps more hands-on experience with outdoor activities may be the way to mitigate some of the "textbook experiences" her elders had to endure in the classroom:

> With this information, I believe implementing activities that include students spending more instructional time outside rather than inside is important to helping these younger students' minds grow. (Elder Assignment, Part 2, p. 8-9)

Karolina recalls that her elders did not have any support at home in order to complete their assignments. She mentions that she will consider how her future students may be affected if they do not have anyone at home. She states that she will offer support to these students:

> As far as at-home support or community support, my elders' answers have made me question how different educational support has changed in just a few decades. For the future, I think it is important that as a teacher, I can encourage the need for more opportunities of support to help those students in need who don't have anyone at home that are able to educationally support. (Elder Assignment, Part 2, p. 9)

In addition Karolina mentions that her understanding of her elders past helps her consider future practices in the classroom. Throughout her reflection she acknowledges the social injustices that have affected her and her elders directly. She leverages these experiences for future changes that she would like to implement in her classroom:

> This reflection allowed me to realize the change I want to be in the educational world in the future. While continuing my education, I will gain more knowledge on how to be the teacher my elders never had and possibly, who I never had as well. (Elder Assignment, Part 2, p. 9)

Karolina emphasizes that she hopes to implement more relevant activities such as taking the students outside and having more hands-on activities in class. She also plans to incorporate some learning support especially for students that may not be able to get assistance with assignments at home.

Clara's reflexión was also rooted in acknowledging the social injustices that her elders along with friends had endured during their formative years. Clara mentions that she believes that students should be served and included in all lessons regardless of their native language or identity. She goes on to discuss how she plans to make her classroom inclusive so that all students feel welcomed. She approaches this plan by discussing ways on how she can include multicultural approaches in the classroom:

> After reviewing and discussing all of my interviewers' responses with mine. I can use the knowledge I've gained to foster an inclusive environment in my classroom. Regardless of their backgrounds, I will make my lessons and classroom welcoming to all learners. If a student is from a ranch, city, or town, for instance, I will incorporate lessons with that in mind so that every student can experience it. This also helps students from those locations feel recognized, and it provides a learning opportunity for students who

> are not from those locations. In order to give my students the opportunity to learn about both their own culture and other cultures, I will also include greater cultural variety in my classroom. When diverse cultures are introduced to children in the classroom, they feel more at ease and secure dealing with these differences. (Elder Assignment, Part 2, p. 4)

Clara also draws from her own experience and from her elders' experience with outdoor learning and uses this to consider as in her own classroom as well. She feels that it is important to provide learning opportunities beyond the classroom. “I'll also use my position as a teacher to provide students with learning opportunities outside of the classroom” (Elder Assignment, Part 2, p. 4). In addition, Clara feels that learners need a variety of visuals and native representation in texts in order to support learning in her classroom:

> To help young learners better understand the material, I'll use a variety of visual, auditory, and hands-on exercises. I'll also provide the students with chances to express what they know about the lesson in their own language. Giving students the chance to demonstrate what they are learning in their home language alters the outcome because most ELLs understand what they are studying but struggle to translate it to the language they are learning. Additionally, it helps ELL feel accepted and less ashamed of their language proficiency. (Elder Assignment, Part 2, p. 4)

The testimonios and reflexións from the elder assignment were utilized as a tool to provoke critical consciousness. The purpose for this provocation is to get the participants to

collectively bring forward systemic social justice issues that are deeply rooted in the foundations of modern educational systems. By bringing the voices of the oppressed forward, we begin to see the power differential shift as preservice teachers become the agents of change, thus causing a disruption of the dominant paradigms in monocultural curriculum that suffocate other ways of knowing. Focus group 1 and Focus group 2 are thereby categorized as a convergence of reflexións since the combination of these critical approaches meet to cause a disruption of the dominant positivistic structures embedded in science curriculum. The convergence of the three data points (elder reflexións, testimonios from Focus Group 1, and testimonios from Focus Group 2 led to five emerging themes: 1) the malignancy of monolingualism; 2) the subtraction of land and culture from science education; 3) the impact of science without context; 4) elder knowledge as science pedagogy; and 5) land and place as the context of science learning.

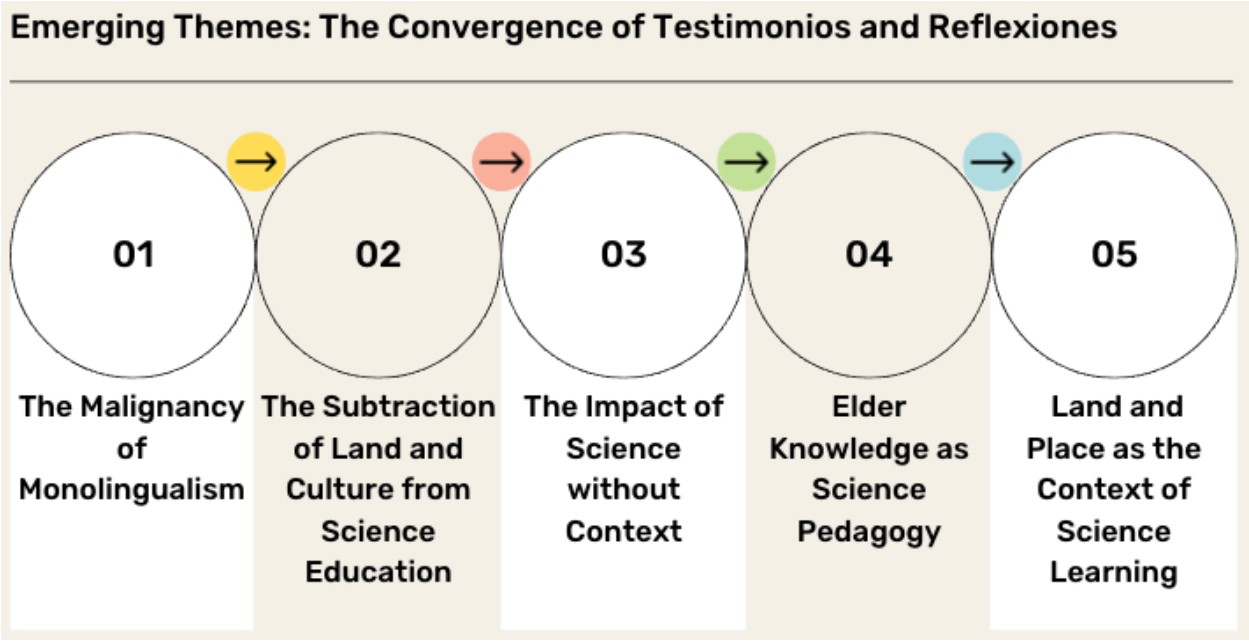

Figure 4: Emerging Themes from the Convergence of Testimonios and Reflexiones

Theme #1: The Malignancy of Monolingualism

In order to situate you in the perspective of the participants' experiences, I will start with a brief historical context. Access to bilingual education has a violent origin rooted within the confines of social political injustices. For instance, schools deemed “the use of Spanish by students in South Texas as a “social problem” and would physically punish students and humiliate them for speaking Spanish (Hurtado & Rodríguez, 1989, p. 402). It was not until the 70's that the bilingual landscape began to shift, and Spanish speaking was beginning to be tolerated in the classroom (Hurtado & Rodríguez, 1989).

According to the participants' experiences and the retelling of their elders' experience, they did not receive instruction or have access to any alternative materials for them to reinforce their Native language in the classroom. Participants reported that both they and their elders learned science through textbooks and worksheets written in English. Based on the accounts of the participants, the purveyors of knowledge, is characterized mainly by the curriculum that was conveyed through countless worksheets, textbooks and didactic lectures.

This is further emphasized in the voices of the participants. The participants share their own personal experiences as well as the experiences that their elders endured. The participants retell some of the systemic injustices that the elder’s faced during their formative years. The accounts of these experiences are mentioned in the transcript below and categorized by the names of Alex, Karolina, Raquel, and Clara, respectively.

Alex states that the elders they interviewed mentioned that they were prohibited from using their native language. Alex further describes that elders recall that the prohibition of native language was emphasized by physical and emotional abuse. Consequently, the elders were fearful of speaking Spanish. “One elder I interviewed could not use their native language at

Theme #1	**The Malignancy of Monolingualism** Systemic issues and social injustices in bilingual education *"In her school, she was not able to speak Spanish and was strictly told only to speak English."*
Theme #2	**The Subtraction of Land and Culture from Science Education** Dismissal of other ways of knowing *"Not using funds of knowledge is the same thing as just using the textbook."*
Theme #3	**The Impact of Science without Context** Decontextualizing science by teaching using only textbooks and worksheets *"Then I'd say, just like the main difference between traditional science and everything else would be that traditional science, it was kind of like in a textbook, like fully studying a lot of worksheets and not many hands-on activities, while lived experience is all of this is actual life."*
Theme #4	**Elder Knowledge as Science Pedagogy** Leveraging elder knowledge and funds of knowledge *"Elders grew up doing science in their community. They are able to teach their grandchildren about plant remedies for sickness and health."*
Theme #5	**Land and Place as the Context of Science Learning** Contextualizing science learning using land and place *"Learning about land and place helps students build towards cultural understanding"*

Figure 5: Descriptors of the Five Emerging Themes

school. If they were caught speaking Spanish they were physically punished and disciplined" (Focus Group 1, p. 1).

Karolina also mentions that her elders were also prohibited from speaking Spanish at school. She states her elders also endured punishment for speaking their native language. She adds that teachers were not welcoming or accepting because of their intolerance for speaking Spanish. She states that at the time her elders attend elementary school, they did not have access to a bilingual program.

> In my interview, one of the challenges faced was not being allowed to speak Spanish in the school setting. Punishments were given to those who did speak Spanish. There weren't any bilingual programs. The main struggle here was being afraid to express who they were through their language. Students and teachers were unaccepting. (Focus Group 1, p. 1)

Similar to the other elder and participant's experiences, Raquel states that her elders also mentioned that they did not have any support for learning science as all content was taught in English and their native language is Spanish. Raquel previously mentioned that not only did her elders not receive support at school because everything was Spanish but they also did not have support at home because their parents also spoke Spanish. Raquel further expresses her disbelief and she mentions that not even the Department of Education provided support for our Chicanas/Chicanos population.

> One of the challenges in my interview was there were not enough resources to help them be successful while they attended school.

> There was not enough support from both the community nor the Department of Education. (Focus Group 1, p. 1)

Clara also states that her elders were also refused the ability to speak Spanish in the classroom. She mentions that the elders reported that they were restricted to only speak English. In addition to vehemently suppressing one's native language, Clara stated the school did not provide any instructional support or resources. Clara implied that mitigating factors such as contextual factors were not considered in the curriculum as evident in the lack of funding available for students in rural areas. The lack of resources and academic support left the elders feeling excluded from educational opportunities.

> One of my elders mentioned that she faced challenges with her language. In her school she was not able to speak Spanish and was strictly told only to speak English. Due to that fact, she felt ashamed to speak Spanish in the classroom. My other elder felt that he didn't have many resources offered to him at school because he lived on a ranch so he felt that there were not many programs or resources offered to him. (Focus Group 1, p. 1)

Although these experiences happened in a time when Bilingual Education was not available in public schools, the hidden curriculum of monolingualism still lingers as its palatable undertones are still present in school systems today. For instance many schools lack sufficient bilingual resources and some schools promote a full immersion model better known as a sink or swim. These full immersion English only models are divisive as it may force the student to feel like they need to assimilate. This may contribute to the subtraction of the students' cultural identity as native language skills are not reinforced in the classroom (Valenzuela, 1999). Thus

leading to the feeling of "otherness" (Staszak, 2009). These feelings of otherness may affect the social emotional wellness and sense of belonging in the classroom.

Although the four participants previously expressed their feelings of "otherness" in respect of their own experiences in elementary schools in their autobiographical findings that reflected their childhood. They were asked to share if they believed that these negative stereotypes still existed today. Most of the participants mentioned the stereotypes they experienced which are noted in their respective autobiographical component above. However, one of the participants mentioned something different. She provided another example of what she believes is a form of negative stereotypes that she encountered perpetuated by immigrant parents themselves. She describes that in her experience some parents do not want their children to speak Spanish as they may believe that this may limit their children's opportunities due to the negative connotations that surround being Hispanic. She expressed disdain for such ideologies and implies that this may cause subtraction of one's culture. She proposes teachers should allow students to develop both languages in the classroom.

> *Researcher*: Do you believe that speaking Spanish or being bilingual still has the same negative stereotype that the elders experienced?
>
> *Karolina*: Yes, I have some friends. Their parents are from Mexico. They came to the United States and they told them, "No, my priority for you is to learn English. Forget about Spanish. Olvídate de Español." I don't agree with that, but to me, that's the way they see things. They lose their native language and they assimilate so they can learn English so their life could be easier because that's

> the majority language here, but you're stabbing a culture in the back and you're not able to develop your own native language. I feel like if we as educators let them use their native language, they can develop both their native and their English or the language they choose to develop. (Focus Group 2, p. 20)

As the discussion about their experiences with negative stereotypes in their early childhood science classroom continued, the participants began to share how the experience of feeling "othered" affected their social emotional well-being. During the discussion, I observed how participants used nonverbal cues such as nodding in agreement as they echoed the same sentiments of their own oppression and injustices they have endured. Thus building a sense of collective solidarity (Anzaldúa, 1987). The emotional distress that these experiences caused the students became audible in their voice inflexions and tones. Some of the participants' voices became elevated with anger as they described their experiences. Other participants' voices cracked while they looked down or would break eye contact during these discussions. In addition to how they felt, some of them mentioned how various mitigating factors such as limited access to resources and lack of acceptance also affected them. The lack of resources and acceptance of native languages spoken in the classroom were also previously reported by the participant's elders. This is significant as it represents the lack of changes within the stagnate system.

Alex previously mentioned that their native language was Spanish. Despite Alex reporting this to the teachers and the school district, the school and the teachers decided that all of the curriculum that Alex received would be in English. In addition to providing only an English curriculum, Alex states that teachers only decided to focus on State tested subjects such as reading, writing, and math. Alex recalls that the specific subjects of science and social studies

were not taught to them as the teachers did not consider them as significant as the state mandated, tested subjects. Alex further recalls that they felt excluded from learning science because they were considered an ESL student:

> Even though the teachers knew that my second language was English, all of my courses were taught in English, and honestly, I feel since I was an ESL student, they put more importance on reading, writing, and math and put aside teaching me social studies and science. (Focus Group 2, p. 22)

Raquel previously reported that she alongside her parents were migrant workers; thus, she moved around frequently. She recalls that in her experiences up north, she felt alone and isolated away from friends and family. She also remembers that although the school she attended had a diverse ethnic population, she still felt alienated. Despite the ethnically diverse population, she stated that she could not relate to others and felt a pervasive sense of "otherness" from her peers. This implies that her classroom was not an inclusive or welcoming space for her despite the presence of a diverse array of cultural representations situated in the classroom, providing a clear statement of her experience: "I went to a school where I felt like I was the minority and I felt like I did not belong there because I wasn't like all my classmates" (Focus Group 2, p. 23).

Although Clara's native language was English, her memories of her elementary school in the Rio Grande Valley included experiences directly observing exclusion and social injustices occurring in front of her eyes. She recalls how some of her classmates were not allowed to speak Spanish in the classroom. Clara states that she remembers the teacher intentionally ignoring them and excluding them from classroom activities:

> I do recall students who spoke Spanish as their first language not being permitted to speak Spanish in the classroom. As a result many of them felt embarrassed and excluded from classroom activities. (Focus Group 2, p. 24)

As the participants continued to discuss their collective experiences, the conversation stopped abruptly, and there was a long, uncomfortable pause. They stared at each other for a moment in what appeared as silent consensus of confirmation. I then asked them to consider how their experiences compare to that of their elders' experiences in school. They pondered this question as they considered the common themes amongst their responses. They finally responded and concluded that the theme that related to both their experience and that of their elders was that of "the universal experience". The conversation of what the universal experience meant to them elicited provoking thoughts of questioning current science curricular practices, bringing us to our second major theme: subtraction of land and culture from science education.

Theme #2: The Subtraction of Land and Culture from Science Education

In this theme, the findings show that according to the participants' collective experience, science curriculum and instructional support has not changed much in the last forty years. This was evident as all the participants and their respective elders mentioned that they had experience with science in their everyday life, but they all learned science through canonical context (Aikenhead, 2005). This is to say that the school system did not leverage their cultural capital or recognize their knowledge of everyday life via ethnobotany as a valid form of knowledge. Instead the schools used prescriptive science curriculum that decontextualized the curriculum via memorizing facts and positivistic pedagogical approaches. The participants began to discuss how

the elders experienced science in their classroom and compared it to the curricular practices used in today's science classrooms.

When participants were asked what happens when funds of knowledge are not used in the classroom, they referred to this as a "universal science experience". They defined the universal experience as "traditional way of teaching" or "teaching with textbooks" as opposed to leveraging their cultural intuition.

> Not using funds of knowledge is the same thing as just using the textbook. This is the universal experience. Using this universal experience rather than their own personal experience, it just loses the students from learning. Back then the resources were limited and now I feel like they're still limited in a way because they're just using old ways of teaching with textbooks and stuff, which doesn't really interest the students as much as using technology or hands-on activities or games or real-life experiences and stuff like that. (Focus Group 2, p. 12)

It is noted that based on the elder interviews and reflections that all participants reported that their experience and their elder experience with learning science education was based solely from learning with the textbooks and worksheets. Some of the participants reported that they believe resources do exist but the teachers "do not always use them" attributing to what they consider the universal way that science is taught. "I'd say the resources are there, but the teachers just don't always use them" (Karolina, Focus Group 2, p. 13). They also believe that this way of teaching is due to lack of knowledge in pedagogical strategies. They alluded to the systematic and hegemonic ways of teaching that is perpetuated through cyclical teaching habits that cycle

from one teaching generation to the next. This is noted in the conversational transcript excerpt below:

> *Researcher*: Why do you think that is?
>
> *Karolina*: Because they're used to it. That's how they learn. They're like, "We learn this way, they're going to use it."
>
> *Clara*: Maybe because they're comfortable. They're too comfortable to actually engage with them, make that cultural connection. I don't know. Not saying that some, but some teachers don't go out of their way to really build a community in their classroom, establish it's okay to be different, and that the students' input matters. They don't try to encourage participation. They just go with the flow and whatever happens, happens, but we should though. By incorporating their culture, they'll be more willing to participate.
>
> *Alex*: Maybe they also don't know how. They grew up learning it from another teacher. They don't really know how to get out of their comfort zone and actually involve the student's culture or prior knowledge into the science classroom.
>
> *Clara*: I feel like it's just easier for them to go based off of textbooks or based on how they were taught because it's like the way we said, they're used to it, they're used to learning and teaching that way. (Focus Group 2, p.13)

A shift in the conversation occurred when one of the participants questioned if the textbook or “universal method of teaching” was really to blame for the lack of learning science or being culturally responsive. Raquel discussed how their family lived in Mexico and they learned this “traditional way" and they seemed very knowledgeable in the subjects of science and math. After I asked if the people in question also spent time outside, the participant began to think about the correlations between being outside with learning and doing science. The transcript of this interaction is noted below:

> *Raquel*: I don't know how my grandma learned or how my Dad learned because they were taught from a book in Mexico. They obviously learned because my Dad loves Science and History, but how did they learn? How did they learn what nowadays we can find on the internet? The teachers must have been super smart because I don't think a lot of us can teach that way, out of just top of our heads.
>
> *Researcher*: Did they also spend time outdoors?
>
> *Raquel*: Yes. My Dad, he always worked in Monte so he was always outdoors. I remember my Dad used to say that he would spend a lot of time outside. He loves science. I guess that was where his experiences came from too. The elder that I interviewed, he grew up on a ranch, so he grew up with a lot of plants, animals. He's able to identify a lot of those science-related environments. I feel maybe now since a lot of students aren't outdoors, they don't get to experience the same way as back then. Maybe that's why a

> lot of elders know a little more and enjoy science a little more than students now. (Focus Group 2, p. 13)

The participants started to make connections between the land-based knowledge they learned directly from their elders and their experiences with current science classroom practices. This thought was further explored as the participants were asked to consider how they would challenge those so-called universal science experiences in their own classrooms. The participants suggested their own ideas such as "encouraging them to explore outdoors" and "let them find a topic that interests them" while others suggested leveraging place and land as a community resource. Alex emphasized using our native environment such as soils to form an investigation:

> Maybe if they were learning about the different soils in the Rio Grande Valley, the teacher could bring in the different soils with trays, then students would be able to separate it to label the layers of the soils, and so on. (Focus Group 2, p. 15)

Similarly, Karolina brought up the topic of including the community as a resource in the classroom. She suggested that teachers should consider bringing outside speakers into the classroom to help students conceptualize other ways to learn science. Interestingly, Clara mentioned that she would bring a farmer into the class instead of the anticipated traditional answer of a scientist:

> *Karolina*: Or bring in outside people into the classroom to speak more on different topics.
>
> *Researcher*: Could you provide an example of who you would bring into class?
>
> *Clara*: A farmer. (Focus Group 2, p. 15)

This response led to the discussion of the next question which asked the participants to compare and contrast what they considered "traditional science", lived experience (traditional knowledge), and storytelling. This led to the next theme: the impact of science without context.

Theme #3: The Impact of Science without Context

In this theme, the participants challenged the preconceived notion that science is separated from lived experience (Kuhn, 1962) as I asked them to consider the possibility that traditional knowledge can be science and that, likewise, Eurocentric science can be gained through lived experience. When I asked the participants if they considered the farmer to be a scientist, they all agreed, positing that "the farmer learns by collecting data and through trial and error through lived experience" (Clara, Focus Group 2, p. 29). This point led to me asking them to compare and contrast between Eurocentric science and lived experience. Interestingly, they were able to identify an example that traditional science knowledge can be gained through lived experience via the example of the farmer, but their perception of Eurocentric science was impacted by the stagnant science teaching practices still used today. Referencing back to the "universal science experience", (e.g., Eurocentric science) the participants contrasted how they experience science throughout their everyday lives with how it is presented when "studying from a textbook". These experiences are expressed throughout the study but are revisited here as they express the differences between lived experiences and traditional science through their own lens.

Alex believes that traditional science is different from lived experiences in that traditional science eg. Eurocentric science is taught from someone else's point of view. From their perspective, traditional science teaching is not taught within the social cultural context. According to Alex, traditional science is taught with textbooks and worksheets that are generalized and not culturally relevant. From Alex's perspective, this makes the traditional

classroom science teaching a one-sided affair, where the teacher is the locus of knowledge that the student can either receive or fail to receive:

> Traditional science, I feel like it's whatever is given to you. I guess if you're really interested, you can explore more, but I feel like whatever the teacher gives to you is what you're learning, it's one-sided because it is from someone else's point of view, and I can't relate to that because what if you haven't been exposed to that. (Focus Group 2, p. 8)

Alex goes on to explain their definition of how they perceive lived experiences. According to Alex, lived experience is different because you can learn information in "different contexts" that relate to real scenarios and they are relatable because they apply to real life.

> I think it's different because when you're learning from an elder, or from your own personal experience, you interpret information differently. You get informed by an elder or your own self, you can, I guess, analyze different things. Like, I'm pretty sure in class you wouldn't learn about remedios or plants that can serve as remedies in contrast to when you're with Tia or a grandpa, they'll be like, "Oh, it comes from this plant, and it can help you with this sore throat." You're learning something scientific about nature but in different contexts. (Focus Group 2, p. 7)

Alex reiterates that lived experiences are valuable in that students are doing science and not just reading about it or experiencing it in a context that is far removed from their everyday life and culture.

Karolina, on the other hand, discusses her relationship with science in the context of everyday life. She states that everyone makes observations, inferences and these inform our decision making. She further states that traditional knowledge is data that has been gathered throughout time to inform decision making:

> We make observations every day in the real world, and that's how we go through life. We infer certain situations that we're put in, based on what we want to do next, like our plan of action. Then through collecting data through everyday lived experience or traditional knowledge, we change our future events or plans for what we want to do. Then I'd say, just like the main difference between traditional science and everything else would be that traditional science, it was kind of like in a textbook, like fully studying a lot of worksheets and not many hands-on activities, while lived experience is all of this is actual life. (Focus Group 2, p. 5)

Karolina directly contrasts her understanding of science as lived experience with her observation of traditional science teaching as a process that overemphasizes textbook learning and "a lot of worksheets". Karolina's summarization of the latter as the "universal science experience" was reflected in her elders' experiences of learning science as well, emphasizing a lack of growth in pedagogical approaches to science teaching during this period. Raquel agreed with Karolina's identification of the "universal science experience" in that she states that science is always taught in the same manner with the same pedagogical approaches as opposed to exposing students to different experiences. She also agrees with Alex in that she also believes that the textbook

symbolizes someone else's experience and knowledge — a Eurocentric science approach. To Raquel, exploring science via textbook decontextualized and depersonalized the experience of "doing science":

> It's the same content every year for traditional science. I feel like in school, the way it's textbook, so it's the same thing every year. They're learning basically the same science projects every year, but in life, we're doing something different every day. It's not the same. Because they're your own experiences, whereas over here with the teacher, it's somebody else's experiences that put it in a textbook. (Focus Group 2, p. 7)

She states that lived experiences are not the same as Eurocentric sciences because science through lived experiences may be connected to relevant to real life whereas "Eurocentric science", through her eyes, is primarily taught through rote memorization, textbooks, and the same one size fits all curriculum.

Clara struggled with understanding this question. She could not contextualize the meaning of this question because she believes that "we experience science in everyday life. How can everyone have a separate meaning between science and real life?" (Focus Group 2, p. 7). Clara believes that lived experiences are synonymous with science, having previously chosen a farmer as a proposed speaker for a science class. She recognized that the farmer has knowledge of the land and agricultural practices that have been tested through trial and error. Clara acknowledges that the farmer is in fact a scientist by implementing all science processing skills through practical applications situated in real life scenarios.

Theme #4: Elder Knowledge as Science Pedagogy

As engagement in the focus groups continued, I continued to observe the non-verbal cues such as smiling, nodding their heads and leaning in as they listened intently to each other. They now seemed to be more comfortable in expressing themselves as they found themselves agreeing with one another engaging in what appeared to be a sense of familiarity. This was portrayed as the participants began a crosstalk between themselves as to their elders' experience with the land and nature. It is important to note that even though they previously revealed their elder's experience with nature and remedios caseros in their elder assignment independently, this was the first time they shared this casual exchange of conversation with one another. As I sat there observing the discussion I noticed the non-verbal cues such as their heads nodding and smiling at each other as they listened to each other discussing the similarities of their elder assignment. The participants seemed surprised as their eyes widened to hear each other's common elder responses with their experience in nature. This became a pivoting point for them as they began to reflect on the value of community knowledge and cultural intuition (Bernal, 1998). When I asked them to describe why community knowledge such as elder knowledge is important for science pedagogy, their responses in the reflections and discussions revealed elements that supported funds of knowledge (Moll, Amanti, Neff, & Gonzalez, 1992) as well as epistemic agency (Stroupe, 2014). The participants also alluded to ways that they can leverage elder knowledge as cultural capital when they began suggesting how it may be incorporated as a pedagogical science approach.

Alex mentioned that they thought community knowledge is essential in promoting environmental awareness of local bioregional resources. In addition, Alex mentions that elder knowledge is valuable as this can be leveraged as culturally relevant references points when teaching science:

> Community knowledge is important because students need to be aware of events that are taking place in their environment. They also need to be informed about the type of resources that are at their disposal. This can tie in with the types of resources and locations students can visit to learn and expand on their knowledge. Elder knowledge can stay ingrained in a student's life because it is told by someone important in the students life. Elder knowledge can help educate school children to learn science because they are more knowledgeable in these areas, especially regarding knowledge of plants. When the teacher also incorporates that, they'll be interesting because they're like, "Oh, I'm learning about my culture. I learned that from my grandma, so this is interesting to me." Also, by making it culturally relevant, you're asking about what they believe in, so you're giving them importance or you're making it shown that they matter and their beliefs or their remedies, or anything. (Focus Group 1, p. 2)

Alex finds significance in utilizing place and cultural knowledge as a resourceful pedagogical tool. Alex believes that utilizing this knowledge will help it become "ingrained" because it connects the curriculum to the student's personal life. Alex also emphasizes environmental awareness and knowing "place" as a resource that can be utilized by students outside of the classroom.

Karolina mentions that she believes that elder and community knowledge are significant because these can be used to make connections between funds of knowledge and culturally relevant pedagogy:

> I believe elder and community knowledge are important for science pedagogy because it allows students to understand their background like culture and stuff. When learning science they are able to make connections between the content and their prior knowledge. Having a connection between the two will make their learning more meaningful. (Focus Group 2, p. 10)

Karolina mentions that elder knowledge and community knowledge is important for science pedagogy as she believes that it allows the students to make culturally relevant connections between their funds of knowledge and science content.

Raquel's beliefs about integrating elder knowledge in science has sociocultural implications. She states that elders' cultural knowledge may be used as a science pedagogical approach because students can connect to their family. She uses her own example of gardening techniques that she learned during her childhood from her elder to demonstrate the lifelong impact of learning from someone that you “trust and know”.

> Elder knowledge of plants can help students learn about science because they hear from adults who are well-informed about that subject and children trust that the adults know what they are teaching them. I know that when I was growing up as a child I would always follow my grandma when she would water her plants and take care of her garden and as an adult now I get to

> remember all the techniques that my grandma does to take care of her plants and trees. (Focus Group 1, p. 2)

Raquel goes on to provide other examples of elder knowledge in indigenous medicines and how that may relate to teaching science. She emphasizes again that elder knowledge may help students feel connected since “remedios caseros” are used in their homes and it is part of their culture.

> Another example would be when elders teach students about specific plants, such as native plants that they might use for remedios caseros, and when a teacher connects their science lesson to the students’ knowledge of native plants, it helps students feel more engaged and interested in learning science because they feel connected to the lesson. Students can then approach the teacher and also provide their knowledge on being able to identify and compare the structures of plants and other things. I feel like the teacher can use the students' own background knowledge, then maybe the students make connections with the teacher and what they're saying and stuff like that. (Focus Group 2, p. 10)

Raquel’s examples demonstrate her thinking through the process of making curricular changes through sociocultural contexts, as leveraging funds of knowledge as well as intentional pedagogy that yields in relevant meanings.

Clara emphasizes that she feels that her elders are “knowers and doers of science”. She feels that elders as she acknowledges the historical contributions of elders' knowledge in indigenous medicine:

> Elders grew up doing science in their community. They are able to teach their grandchildren about plant remedies for sickness and health. When elders share their knowledge of plants with their children or grandkids, it helps students learn more about science. When elders provide opportunities for students to learn how to care for a plant, such as a garden, students gain knowledge of how to identify and record the changes of the plants and the land, these are the same principles that are seen in the State standards kindergarten, first grade and other TEKS. (Focus Group 1, p. 2)

Clara connects her elders' knowledge of plants to the State standards in that the standards emphasize processing skills which are the "same principles" that her elders learned through hands-on agricultural approaches.

All participants agreed that utilizing elder knowledge as a form of cultural capital in the classroom is a possible way to bridge culture and science concepts in the classroom. Although their discussions and reflections led them to discuss how these pedagogical approaches can be utilized in this region, throughout the interactions participants also mentioned aspects of land and place. This led to also exploring how learning about local land and place could help students build towards cultural understanding of themselves and others.

Theme #5: Land and Place as the Context of Science Learning

Throughout the reflections and discussions, participants expressed their pride for the Rio Grande Valley, as they call this "place" their home. All participants mentioned aspects of cultural intuition and cultural knowledge that correlates directly back to a place which is situated within a community (Calderón, 2014). Furthermore, all participants drew from the lived experiences of

their elders as they discussed the origins of their elders' knowledge systems. Elder knowledge systems were passed down through dichos, storytelling, and experiences in the community (Bernal, 1998). Participants center their elders' knowledge as community wealth; they see their elders as “knowers and doers” of science. This reflexive activity promotes a critical consciousness as they recognize that cultural knowledge is situated within their land and place. Participants begin to consider their relationship to place and seek to leverage this as a form of participatory curricular approach. They allude to participatory action by means of exploring experiential learning through knowledge systems that were passed down by ancestors via culturally sustainable pedagogies that can further be utilized as a way to implement multicultural approaches in their classrooms.

Although their experiences are grounded within this region specifically, participants also considered how knowledge of land and place could be used as a tool for understanding themselves and the culture of others (Bernal, 1998). Each participant responded with ideas on how they would utilize land and place in order to gain greater understanding of their students.

Alex approaches knowledge of land and place through a multicultural lens as they mention that they understand that not everyone in the classroom falls into the “same category”. Alex suggests that teachers should leverage knowledge of place in order to consider where students come from and how they learn:

> Learning about land and place helps students build towards cultural understanding in the sense that not everyone in the classroom falls into the same category. We should be open to diversity and learn about “place” so help us learn about students. In addition land and place can also serve as a resource to developing

> language acquisition for emergent bilinguals. This can occur by teachers incorporating native language for context. (Focus Group 1, p. 4)

Alex also implies that teachers can utilize land and place in order to understand sociocultural factors that may assist in language acquisition. Alex suggests that language acquisition may be supported in the classroom if teachers use the native language in the area.

Raquel believes that place and land can be used as a tool for "drawing students into a lesson." She also alludes to how place and land will intrinsically motivate students to learn science since it is relevant and meaningful to students' lives: "It allows for students to learn more about their community and the things around them. When we relate our lesson to a place closer to home, the students will be more drawn to learning" (Focus Group 1, p. 4).

Karolina implies how exploration of land and place may contextualize science learning in that students can learn their historical roots and culture. She also alludes to integrating a cross curricular approach in science and history as she mentions that students may learn about their ancestors and their culture:

> Having students learn about local land and place can help students understand where they come from and their history. Further investigating the community and how they interact with it allows them to understand their culture. The land and places they explore may also be where their ancestors explored at one point in time. (Focus Group 1, p. 4)

Clara suggests that one's identity may be attributed to where one is from. She implies that land and place can be utilized to begin to understand the foundation of our own identity, which is inseparable from its context:

> Many people are defined by where they are from. Here in the Rio Grande Valley we have many Hispanic individuals. It is land/place that contributes to cultural understanding of ourselves. Since we live near the Mexican border we can learn about different cultural practices such as remedies and music. (Focus Group 1, p. 4)

Clara also alludes to borderland pedagogy as she suggests that since we are situated in the Rio Grande Valley she hints that teachers may use cultural knowledge in the region to learn about others.

Participants embrace the stories of their elders and ancestors and value them as cultural capital (Yosso, 2005; Bernal, 1998). The participants collectively see cultural knowledge as an opportunity to contextualize learning science and make learning relevant and meaningful to their students. Furthermore, participants believe that community, or "place", can be leveraged in teaching and learning, as it may be utilized as a vehicle to connect such concepts such as multicultural approaches, cultural understanding of oneself, and intrinsic motivation for learning. This suggests that perhaps utilizing one's sense of place may begin to embrace ancestral history, native language, and understanding their epistemological ways of knowing.

Chapter IV Summary

In this chapter, brief biographical synopsis was provided for each participant, establishing context for their stories and the stories of their elders. These cross-generational stories were bridged through testimonio and reflexión, leading to the identification of common themes that

connected the stories and experiences of participants and elders with respect to the impact of subtractive teaching practices on Chicanx engagement in science. Major themes identified by the participants include challenges in bilingual education, stagnation in science teaching, tensions between lived experience and traditional science teaching, elder knowledge as a form of science pedagogy, and the need for leveraging community. In Chapter V, I will provide an in-depth discussion of how my proposed model addresses these themes in service of forging curriculum that not only includes, but actively recognizes and honors culturally relevant ways of knowing via critical conscientiousness toward transformational practices. This chapter will also provide a discussion of how these findings fit into the greater context of the literature base and implications for the future.

CHAPTER V

FUERA DE NEPANTLA

"*It has to start somewhere; it has to start sometime.*

What better place than here? What better time than now?"

—Zacharias Manuel de la Rocha

This chapter will briefly summarize the results, reflection of mezclados con mestizaje, implications in science education, and reflections on findings of this study. The summary of the results will provide an analytical overview of the testimonios represented in the previous chapter. For the reflections of mezclados con mestizaje, this discussion will highlight how the themes within the testimonios are reflected within literature that counter hegemonic approaches in science education. I also discuss implications for science education, addressing the notion of curricular paradigm shifts of teacher preparation programs within higher institutions of learning. Finally, the reflection over the findings considers the existing tensions of cultural ways of knowing such as ethnobotany and positivistic mechanisms of current science curriculum.

Summary of Findings

The Chicana testimonios of both participants and their elders shared here exposed patterns of systemic oppression, inequity inherent in hegemonic teaching practices, and an absence of culturally relevant context in science education. These emerging intergenerational patterns were explored in depth through reflexiones and critical conversations on the topics of social injustices in bilingual education, community wealth, and what counts as science within the RGV borderlands. From these collective testimonios, five core themes emerged: 1) the

malignancy of monolingualism; 2) the subtraction of land and culture from science education; 3) the impact of science without context; 4) elder knowledge as science pedagogy; and 5) land and place as the context of science learning. They will briefly be summarized here to provide context for the subsequent discussion.

Theme #1 - The Malignancy of Monolingualism

This theme explores the detrimental impact of the extreme othering experienced Chicanx learners who routinely experience denial of access to their language as a prerequisite for participating in their own education. Despite a 40 average age gap between participants and their respective elders, they all reported similar experiences of the systemic issues within bilingual education. Participants retell the violence their elders endured. The violence — both physical and psychological abuse — promoted assimilation, isolation, and shame, in order to curb the so-called social problem of students using Spanish in schools (Hurtado & Rodríguez, 1989). Although there has been a slow salient shift in bilingual education, the roots of monolingualism and deficit perspectives are so ingrained in the fabric of institutional policy. According to the participants, their experiences of systemic injustices are exemplified by lack of resources, prohibition of using their native language, alienation, and exclusion.

According to the participants, their elders mentioned that they did not have academic support to help them learn science since the classes were all taught in English. Likewise, the participants reported they personally experienced and witnessed monolingualism in their own classrooms. In addition, elders and participants reported the prohibition of the use of their native language in the classroom. This perpetuated an academic climate that fosters exclusion, alienation, and otherness. This alienation further attributed to a subtraction of their culture and funds of identity, which included other ways of knowing.

Theme #2 - The Subtraction of Land and Culture from Science Education

This theme focuses on the participant's perspective of how science teaching and learning has been conducted the same way for the past 40 years. Both participants and their elders reported that their main resource for learning science was attributed to textbooks and "countless worksheets". The participants deemed this experience as the "universal way of learning science" since their elders also learned science this way. Although the participants all agreed that the textbook experience was "universal", they also identified the stark contrast between this educational monolith and the way their elders learned about the natural world around them. In short, the participants came to recognize that their elders who learned science did so through a cultural knowledge of land, by spending more time outdoors and interacting directly with land and nature. They drew pedagogical connections between cultural knowledge and ways of knowing, leading to discussions of how they may begin to enrich their own classrooms. Participants proposed exploring integration of cultural ways of knowing by considering using the local "soil" of the land to engage students in inquiry of their place. The participants also discussed inviting speakers with cultural knowledge of land and place — local farmers, for example — into their classrooms.

Theme #3 - The Impact of Science without Context

As participants were asked to compare and contrast between learning science through traditional education and learning science through lived experience, clear tensions between these two methods rose to the surface. Participants and their elders both shared their perception of learning science in the classroom as a decontextualized form of learning that prioritizes textbooks and worksheets over the natural world relevant in learners' environments. Participants implicate this form of learning science as passive, one-sided learning conducted from someone

else's point of view (i.e., a view of the world given by the teacher or textbook), rather than encouraging and promoting the learner's own lived experiences and observations of the natural world. Thus, learners are robbed of experiencing the scientific observations themselves. Participants distinguish their perceptions of their elders' experience with learning science through lived experiences as the "ability to gain and collect data in real life". Participants also implied that in "doing science" that is connected to their culture, they are learning through a culturally relevant context that is situated in their everyday life. One participant in particular struggled with the concept of separating lived experience from the practice of science, considering that direct experience to be the critical element of understanding science. She raised the poignant example of the farmer who uses knowledge of the land and agricultural practices that have been tested through rigorous trial and error, season after season, year after year, within a particular ecological context. This led to the next theme of elder knowledge as a form of science pedagogy.

Theme #4 - Elder Knowledge as a Form of Science Pedagogy

Participants identified their elders as sources of traditional ecological knowledge through lived experiences in their regions and through passed down knowledge, with some focus on passing down of platicas. These platicas led to the collective ideas of how elder knowledge can be leveraged as a form of pedagogy in the science classroom. They allude to its effectiveness as they mention that leveraging cultural knowledge may assist science learning in that it becomes "ingrained" since students are learning from ones they love, providing personal value to learning science as a practice and form of knowledge that relates directly to who they are and where they are from. Therefore, participants acknowledge that their elders' knowledge of ethnobotany, agricultural practices, and cultural history is a form of community wealth (Yosso, 2005; Bernal, 1998). These concepts are modestly reflected in the participants' stories as they share their ideas

of how community knowledge may be used as a tool to connect culture and funds of knowledge. Collectively, they believe that utilizing elders' knowledge as a form of pedagogy will make their lessons more meaningful and provide context as this is rooted within their own experiences, thus putting the participants in the center of their own learning and shifting the power differential back to the students.

One of the participants alluded to the connection between science processing skills found in the State standards to the same processing skills her elders used in "doing science" outdoors through hands-on agricultural approaches. This led to the notion of utilizing land and place as the primary center for learning. Their discussions and reflections led them to discuss how these pedagogical approaches can be utilized in this region, with participants also mentioning various aspects of land and place that could be incorporated into the science learning experience. Not only did the participants explore the benefits of using land and place in this manner to improve adherence to State standards, they also delved into how such practices could help students build towards a deeper and more meaningful cultural understanding of themselves and others.

Theme #5 - Land and Place as the Context of Science Learning

The participants discussed traditional knowledge systems passed down through dichos, storytelling, and experiences in the community. Centering their elders' knowledge as a pool of community wealth, the participants highlighted their elders as "knowers and doers" of science. Although their experiences are grounded within this region specifically, the participants also considered how knowledge of land and place could be used as a tool for understanding both themselves and the cultures of others (Bernal, 1998). Each participant responded with ideas on how they would utilize land and place in order to gain greater understanding of their students, such as using the soil for inquiry, taking their students outside to explore the natural resources

and utilizing our bioregional resources to teach the students about the world around them . They described community and place as a vehicle to connect multicultural approaches, cultural understanding of oneself, and intrinsic motivation for learning, providing a deeper context for science learning that increases the relevance and meaning of the content for their students.

Mezclados con Mestizaje

This inquiry esta mezclado con mestizaje, meaning that it articulates the strengths of ecological cultural knowledge systems and wisdom of our elders while also bringing the social political injustices of the borderlands to the forefront. This provokes necessary critical dialogues about social injustices within bilingual education, community wealth, and what counts as science.

Social injustices within bilingual education are affected by the academic apartheid perpetuated by systemic issues such as funding disparities, stigmatization, discrimination, and lack of culturally relevant curriculum. Funding disparities are attributed to the unequal distribution funds between affluent areas and rural areas. This is due to the common influence of utilitarian social political structures that divide the classes and distribute the funds to the already privileged, a so-called greater good (Rawls, 1971). The disproportionate allocation of funds impacts bilingual programs as it negatively impacts the ability to provide sufficient materials, additional support for bilingual students, and adequate staffing. By design, this reduces the available opportunities for basic liberties and equitable instruction for bilingual students, which may contribute to further class divide within the social political structure.

Although funding may be one of the mitigating factors that contributes to the disparity in bilingual education; the detrimental impact of stigmatization, discrimination, and lack of culturally relevant resources has a profound impact in our community. Subtractive schooling

(Valenzuela, 1999) practices such as prohibiting students from speaking their native language have long plagued our educational systems. This oppressive practice not only prohibits people from speaking their native language, it also erodes their cultural identity at the roots by means of assimilation through cultural epistemicide (Sousa Santos, 2008; Paraskeva, 2016).

Cultural epistemicide within this inquiry is substantiated by the testimonio of the participants and their respective elders. Their collective experiences reveal over forty years of enduring oppression, stigmatization, discrimination, and assimilation in schools. In addition, their experiences also highlight the pervasive Eurocentric teaching practices embedded in the foundation of educational institutions. This was substantiated in the current inquiry: despite reporting rich knowledge of local flora and fauna via agricultural practices and ethnobotany, the participants' and elders' reported that their teachers still approached them utilizing deficit approaches and banking model (Freire, 1970). Based on the participants' experience, the implications of this type of pedagogical strategies reflect Eurocentric positivistic science approaches. In other words, their wealth of cultural knowledge was decontextualized and ignored as an understanding of science, situating the students as outsiders to the content, and grading their understanding of science only through the lens of how well they were able to execute rote memorization of content that was outside of their own experience at best, and outside of their own language at worst. In addition, these deficit approaches further perpetuate colonial Eurocentric efforts (Valencia & Solórzano, 1997) that dismiss other ways of knowing (Sousa Santos, 2009). In order to ameliorate this hegemonic approach, leveraging community wealth as a connective framework in science curriculum should be considered.

Community wealth can form a bridge for students who have been disenfranchised through decontextualized science curriculum by connecting science learning to their lived

community. Linking learning to community fosters a sense of belonging as learning becomes contextualized to the cultural wealth and knowledge of the community (Yosso, 2005). This connection may also embrace Chicana cultural history, cultural intuition, and cultural capital (Bernal, 1998). In doing so, we also move toward reclaiming our indigenous ecological knowledge and deconstructing the colonial patriarchal Eurocentric schooling models (Calderón et al., 2012). The aim here is a shift of the core power differential in teaching and learning, giving the power back to the student. Participatory curricular approaches that contextualize science through lived experiences in the community foster such epistemic agency among Chicanx learners. In addition, this curricular approach may lead to critical awareness of environmental issues within their community which may cultivate needed calls to action (Gruenwald, 2003b; Sobel, 2008). In short, if we want our future generation of educators and students to be agents of change, our curriculum must move outside of the classrooms, worksheets, and textbooks that bind knowledge away from its context; it must be experienced first hand in the places where the scientific and environmental challenges of modernity can be observed. To drive this point home, we must critically consider what counts as science in the classroom.

Indigenous ways of living in nature contrast sharply with notions of understanding science from a Eurocentric perspective (Aikenhead & Ogwa, 2007). Eurocentric science is taught through the notions of objectivity and universalism that remove specific social, cultural and historical contexts. The Chicana participants in this study emphasized beliefs about the importance of science curriculum embracing the lessons of indigenous ways of living in nature in order to reach Chicanx learners. In particular, they stressed that learning through lived experiences within the context of one's community, the wealth of elder knowledge, and land

based and place based pedagogy are critical pillars in connecting Chicanx learners with content. Land based pedagogy counters the Eurocentric sciences by focusing directly on the perspectives of ecological sustainability and cultural values that necessitate and drive committed action through the articulation of the stories of indigenous peoples in a given region (Calderón, 2014).

Land based pedagogy is woven into the very fabric of Rio Grande Valley. People in this region grew up living with the land by cultivating it and using its bioregional resources as medicines in remedios caseros (Zavaletta, 2020). This indigenous transnational generational knowledge has been passed down through dichos, storytelling, and traditional medicines. By integrating land based pedagogy and place based learning into science learning we begin to empower and heal our community as we embrace its cultural history, language, and funds of identity (Bernal, 1998). In doing so, we open educational spaces rooted in cultural identity, language, and acceptance. Leveraging our cultural knowledge and heritage empowers the learner as they engage with the community around them by means of interacting through citizen science and ecological stewardship. This type of engagement promotes civic engagement and awareness of the needs of their community through means of critical consciousness and participatory action (Freire, 1970; Giroux, 2016), thus shifting towards a democratic classroom (Giroux, 2016) where the students are the agents of change.

Implications for Teacher Preparation in Science Education

Although higher learning institutions prepare preservice teachers with the necessary skills needed to lesson plan and teach within the structure of the bilingual classroom, the disparity in the bilingual classroom still exists. This may be attributed to the prescriptive curriculum utilized in the school district. This hegemonic curriculum perpetuates teaching and learning within the context of the banking model (Freire, 1970). This prescriptive curriculum is developed to support

the State standardized exam, which was designed utilizing a monoculturalism approach. Its formulation does not consider the culture or experiences that students already bring into the classrooms. I highlight this as a contradiction within higher teaching institutions specifically, as they perpetuate this cycle of monoculturalism by conducting their own practices without employing land and place:

> "The current multicultural science classroom in many countries is characterized by all kinds of disparities in terms of cultures, languages, socioeconomic statuses, beliefs, expectations, age, gender, interests, values systems, worldviews, and so on. Certainly, all these differences pose great challenges for science teachers, especially those who have been prepared in higher education to teach in monocultural classrooms" (Ogunniyi, 2023, p. 395).

One way to mitigate this issue is to prepare preservice teachers and administrators within teacher preparation programs with knowledge of using their land and place as a tool to combat hegemony. Land-based and place-based pedagogy contextualize learning while connecting students to their culture, native language, history, and local bioregional resources. Indeed, the use of land-based and place-based pedagogy may be aligned to State of Texas standards. According to the Texas Essential Knowledge and Skills (TEKS), the State requires "outdoor investigations". Table 1 outlines the amount of instructional time that should be dedicated to such investigations, according to the TEKS standards. Despite State guidelines that establish a need for a significant amount of instructional time to be dedicated to outdoor investigations, the testimonios of our Chicana pre-service science teachers affirm that de facto instruction for the past 40 years has been spent on reading from textbooks and writing on worksheets as evidence of such inquiry.

Table 1: TEKS for Science

Grade Level	% of Learning Recommended as "Outdoor Investigation"
Kindergarten	80%
1st grade	80%
2nd grade	60%
3rd grade	60%
4th grade	50%
5th grade	50%

Source: Texas Education Agency

If the State standards stipulate that children should be engaged in outdoor investigations during instructional time, then it stands to reason that we should consider training teacher candidates by example, using land-based and place-based pedagogies in practice during their own instruction. These land-based and place-based pedagogies need to be implemented within Teacher preparation programs. Pre-service teachers should learn science through the sociocultural understanding of their place. These concepts can be introduced in their Science methods courses by introducing the pre-service teacher candidates to activities that include their own bioregional resources, historical knowledge of the land, and community resources. In addition to them learning about these resources, it is pertinent that we create the space for pre-service teachers to incorporate these tools into their own practice, fostering academic discourse while creating science instructional materials that focus on the community's bioregional resources, culture, and sustainability. By incorporating this approach, we may begin to undo the hidden curriculum of monoculturalism through the practical application of decolonization. "Decolonizing the science curriculum, therefore, might entail modifying or

rewriting the science curriculum in a way that appeals to the intellectual interests of students without resulting in the loss of their sociocultural identity" (Ogunniyi, 2023, p. 394). In doing so, we support our students' funds of identity and voice. By using these critical approaches, we draw on borderland pedagogies (Anzaldúa, 1987) in that we reclaim connection to our language, our identity, our place, and our history.

This critical approach brings awareness to the fact that bioregional factors and contextual factors are not transfixed; by definition, they change from place to place. Therefore, engaging pre-service teachers in critical pedagogies provokes a reflexive state of critical praxis in which pre-service teachers may begin to understand that teacher identities should also change. This reflexivity, along with awareness of the environment, cultures, and epistemological understanding, begins to build on cultural competency. Efforts on building cultural competency should be considered to promote teachers' cognizance of the needs of students from different communities, cultures, and identities. By incorporating cultural competency within science methods courses, preservice teachers may begin to view science as pluriversal. "Such teachers are more likely to create a learning environment where students are able to learn, thrive, and adapt more easily to a multicultural classroom context" (Ogunniyi, 2023, p. 396). It stands to reason that if preservice teachers can view science through the contextual lens of the community and place, then preservice teachers could also utilize this as a tool to understand that science — just like place — can change. In other words, building cultural competency of a place is fundamental as one begins to understand that, in order to teach, you must first understand the roots of the community and their epistemology. It is here that preservice teachers can draw from communities' history, language, and culture. In this regard, the preservice teachers and the

community become the co-constructors of knowledge, creating a multifaceted teaching approach that encompasses cultural components of that region.

Despite this clear need for contextualized science education, our focus groups revealed that education practices appear to be falling short: predica pero no practica. Our focus group participants reported that teachers in the field are neither being properly prepared to implement culturally sustaining pedagogies, nor being trained to utilize the students' funds of knowledge to engage them in inquiry that connects them to their own community or place. The participants believed that both their teachers and their elders' teachers were solely trained on the same deficit approaches that have existed for over four decades within K-12 education, through memorization rather than direct experiences. Their call to action was to see their culture and what they are doing in the classroom connected via the bridge of being face-to-face with their culture and their land through the lived experience of "doing science" locally rather than reading about science phenomenologically. In short, pre-service teachers who have personal experiences exploring their own bio-regional resources are well-prepared to become teachers who can share that knowledge and pride in their community, culture, and place with their students.

Teacher preparation programs must also focus on the need to promote preservice science teachers' recognition of other forms of community wealth. Although teacher preparation programs focus their efforts on pedagogical strategies, differentiated instruction, and instructional planning, preservice teachers may not have enough experiences connecting to the various community resources around them. Therefore, I recommend that service learning be embedded as part of their field hours with emphasis on forging connections to resources within their local communities. While preservice teachers must complete their observation hours within the schools, I believe that teachers should also conduct service community hours to understand

the community as a whole. The preservice teachers should be able to understand the contextual factors in the community by actively participating in them. It is through action and reflexivity that gives rise to critical consciousness (Freire, 1970). In addition, participating in community service as part of their required "field hours" also adds valuable perspective as they are able to see both the disparities and community wealth. This approach may provide teachers with a sense of compassion and insight that may lead to reflective practices and growth as an educator (Biana, 2021).

Although the proposed ideas seem logical and certainly attainable, the educational system has in many ways been reduced to an industrial machine, with school administrations driven by a primary objective of raising student performance on the State of Texas Assessments of Academic Readiness (STAAR) exam in order to secure State allocated funding. As noted above, much of what I am advocating for is already enshrined in the TEKS standards upon which the STAAR is based; however, science is not tested in the STAAR until grade 5, a direct detriment to children's natural inquisitiveness and their development of critical thinking skills. Moreover, this means that teachers may face significant challenges when implementing any experiential learning opportunities in science, as these may be viewed by school administrators as ancillary practices that interfere with STAAR performance prior to grade 5. In order to mitigate this, I propose that land-based and place-based pedagogies can be leveraged as multidisciplinary tools to teach reading, writing, math and science in real world situations. It is here that we invite our stakeholders as community support and re-emphasizing our co-constructors of knowledge within our school districts.

Reflexiones on My Research

As I draw this critical inquiry to an end, I go back to the beginning. As I retrace my own path in this journey I find myself reflecting on what my past educators considered “la niña insolente”. The insolent girl who was told on more than one occasion that her station as a Mexican American girl her role was to be a good wife. My role was to be silent and not bring attention to the “curandera” my great grandmother taught me. I learned then that silence in hegemonic spaces is golden and deafening. The silence shackles you and slowly you can feel yourself seep into the dark corners. You feel yourself pushed slowly into the state of Nepantla (Anzaldúa, 1987). Lost in nothingness, neither here nor there. You do not belong in these spaces, there is no room for you here. You are cast aside. Blatantly belittled by being told that your upbringing was nothing more than wives tales and folklore. Gaslit over and over by the people who were meant to empower you.

My insolence is now my fire. I did not let it die; instead, I doused it with the gasoline of knowledge. This raging fire of knowledge is now my torch, and now I light the path for the castaways, las otras niñas insolentes. I draw from Gloria Anzuldua’s “serpent tongue” as I use my voice and the voice of my ancestors and all the Chicana women that came before me:

> I will no longer be made to feel ashamed of existing. I will have my voice: Indian, Spanish, white. I will have my serpent's tongue - my woman's voice, my sexual voice, my poet's voice. I will overcome the tradition of silence. (Anzaldúa, 1987, p. 59)

I examine the tensions between my cultural way of knowing and my experience as a biologist in Eurocentric science classrooms. I will elaborate my experiences with both of these views of science. In Eurocentric sciences, you must remove all culture, history, and sociocultural

implications; any failure to do so is regarded as a failure of objectivity. In Eurocentric science, you are asked to objectively observe an object or thing — that is, a phenomenon (Jegede & Aikenhead, 1999). You must not look past the target phenomenon; if you do, your observations will be dismissed as biased. Eurocentric sciences taught me that medicines are made solely in a lab; healing is a commodity locked behind a paywall, requiring us to purchase an array of globalized medication.

On the contrary, ethnobotany taught me that flora and fauna are valuable in their own right, and we coexist with them in a relationship built on the foundation of reciprocity. We take care of our land and care for our resources so that they may in turn heal us and provide for us. Ethnobotany is founded on the premise of stewardship and generational knowledge. Cultural knowledge is a connection to place, language, culture, and pride. It is a rite of passage passed down by the secretos de los abuelos, los indios y la familia. To be told these stories and this knowledge is an honor. You are entrusted as a steward of your land, of your place, and of your people. To know ethnobotany, and the properties of each plant and how to care for it, is scientific knowledge that has been cultivated and shared for centuries, if not millenia.

Throughout this journey, I have come to understand that there is not just one way of doing science. There are many different types of approaches, views, and transnational indigenous systems of knowledge. It is in classrooms that we must make space and allow opportunities to welcome all beliefs and other ways of knowing. This approach bridges the tensions between both indigenous ways of knowing and Eurocentric sciences. In doing so, we offer choices of knowledge and open up academic discourse where both educators and students can discuss their ideologies and beliefs without the indignity and shame of being othered, and opening our classrooms to a wider world of what ultimately counts as science.

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APPENDICES

APPENDIX A

APPENDIX A

IRB CONSENT FORM

The University of Texas
Rio Grande Valley

Escúchame, Mi Ciencia Cuenta: Leveraging Cultural Ways of Knowing to Increase Chicana STEM Engagement

This research study is being conducted by Assistant Professor of Practice, Patricia Ramirez-Biondolillo, at The University of Texas Rio Grande Valley.

The purpose of this study is to evaluate the effectiveness of critical pedagogies in the curriculum in supporting pre-service teachers to understand best sustainable practices for teaching science to culturally and linguistically diverse elementary learners.

PROCEDURES TO BE FOLLOWED:
You must be at least 18 years old to participate. If you are not 18 or older, please do not participate. You must also be currently enrolled in the EDCI 3333 course, identify as Chicana/ Latinx and must also have some cultural experience with ethnobotany in your life.
Participation in this study entails 2 round table discussion each taking from (45 to 60 minutes). You will answer discussion prompts that are centered around your previous elder autobiographical course assignment. The prompts will be in an open-ended question format. Participants will write a reflection and then take turns reading their written reflections, then engage in active discussion about the common themes they would use to organize this data.
Information collected from your discussions will be assessed along with information from other participants to improve understanding of critical pedagogies in the curriculum in order to support pre-service teachers and understand best sustainable practices for teaching science to culturally and linguistically diverse elementary learners. To this end, pre-service elementary teachers with similar experiences such as identifying as Chicana/ Latinx and have some cultural experience with ethnobotany have been asked to participate. The discussion will be audio recorded.

DISCOMFORTS, RISKS, AND BENEFITS:
The current study will gather non-sensitive information based on the reflections and open shared discussions. You may refuse to answer any prompts or share in the discussion for any reason at any time during the focus group and do so without penalty. The only risk of participating, beyond risks you likely experience as part of everyday life, would be a breach in maintaining confidentiality of your identity. However, I will make all possible efforts to maintain the confidentiality of your identity by using pseudonyms and deidentification of sensitive demographic and personal information. Any publications using the data from the study will not contain your name or any other information that could be used to individually identify you or your institution.
There will be a $50 gift card compensation provided for participation in both focus groups. Benefits to your participation include having a forum to discuss issues in science curriculum as well as sustainable practices for science classrooms. Benefits also include participating in one of a small number of qualitative studies on the subject. The field of education, and those working closely with science educators, may also benefit from increased knowledge about collaborating well with other STEM disciplines.

DURATION/TIME
Participation should take about 1 hour for each focus group and the focus groups will occur at a time convenient to both the participants and the researcher.

The University of Texas
Rio Grande Valley

STATEMENT OF CONFIDENTIALILTY:
Your participation in the research is confidential. Interview data, audio recordings, transcriptions of the interview and other correspondence will be stored and secured at in a locked file cabinet in the primary researcher's home office. Position and relationships will be summarized to protect your privacy. Names will not be associated with the interview data at any point, as a pseudonym will be assigned to each participant. All transcriptions of audio recordings will be performed by me. All notes, email and phone communications, audio recordings, memos, and other research materials will be kept confidential. Access will be limited to the researcher, the University of Texas Rio Grande Valley faculty members associated with the study, and the Institutional Review Board (IRB). All digital data will be encrypted and physical media kept locked when not in active use.

RIGHT TO ASK QUESTIONS:
Please feel free to contact the researcher with questions or concerns about this research using the contact information listed above. If you have any questions regarding your participation in the study or if you want to verify the authenticity of the study, please contact Dissertation Chair, Dr. James Jupp at james.jupp@utrgv.edu. You may also contact the University of Texas Rio Grande Valley Institutional Review Board (IRB)—confidentially, if you wish—at irb@utrgv.edu .

VOLUNTARY PARTICIPATION: Your decision to participate in this research is voluntary. You have the right to refuse to answer questions at your discretion. You may end your participation at any time, for any reason without penalty. Should you wish to withdraw, please inform me of your decision. If you do withdraw from the study, informed consent documents will be retained and all other data will be destroyed.

CONSENT TO PARTICIPATE:
I have read and I understand the preceding information. Any questions or concerns I have regarding participation in the study have been answered satisfactorily. By checking the authorization box and signing below, I signify that I meet the requirements for participation and I affirm my consent to participate in this study, including recording of interviews. Consent provided below shall remain in effect unless explicitly withdrawn. Further, I understand that I may withdraw from the study at any time, for any reason, and without penalty.

This research has been reviewed and approved by the University of Texas Rio Grande Valley Institutional Review Board for Human Subjects Protection (IRB). If you have any questions about your rights as a participant, or if you feel that your rights as a participant were not adequately met by the researcher, please contact the IRB at (956) 665-3598 or irb@utrgv.edu.

APPENDIX B

APPENDIX B

QUESTIONS FOR FOCUS GROUP 1

1) Based on your elder interview, what are some of the challenges they faced in their years in school (language, resources, etc.)?

2) Based on your recent field observations, describe how science is taught in local schools today. If you have not observed a science class, describe what resources teachers used to teach the content you observed. What are some of the challenges you have seen?

3) Traditional science usually involves observations, inference, data collection, and observing a phenomenon. Compare and contrast this with lived experience, traditional knowledge, and storytelling?

4) Explain your beliefs about why community knowledge and elder knowledge are important for science pedagogy?

5) How does learning about local land and place help students build toward cultural understanding of themselves and others?

APPENDIX C

APPENDIX C

AGENDA FOR FOCUS GROUP 2

1. Discuss what they can do to leverage elders' ways of knowing into their practice.
2. Discuss how the interviews, discussions, and common themes inform their practice.
3. Participants will again take turns responding to these prompts.
4. After the themes are identified within this group, the participants will then discuss as a group how they should be categorized by agreeing or disagreeing based on their own lived experiences.

VITA

Patricia Ramirez-Biondolillo, the author of this dissertation, is a Chicana from the Rio Grande Valley. Patricia Ramirez-Biondolillo graduated from University of Texas Brownsville Valley with a Bachelors in Biology in December 2006. Soon after receiving her Bachelors, she began working as a Science teacher. While working as a public school teacher, she continued her education and went on to receive her Masters in Curriculum and Instruction with emphasis in Secondary Science from University of Texas Brownsville in December 2011.

In 2013, Patricia began working with University of Texas Brownsville as a Science Master Teacher in the UTeach program. Here, she prepared Science and Math pre-service teachers with STEM lesson plans in addition to serving as their field supervisor for grades K-12. She worked in the College of Sciences in the UTeach program for 2 years before joining the College of Education at the University of Texas Brownsville in 2015.

Since then, Patricia has served as an instructor in the College of Education for both the legacy institution and University of Texas Rio Grande Valley for 10 years. Patricia Ramirez-Biondolillo graduated from University of Texas Rio Grande Valley with a doctoral degree in Curriculum and Instruction in May 2024.

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