Through Our Voices: ECE LatinX Educators Understanding and Discussions of Early Science

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Abstract

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School readiness is often defined as being at an expected developmental level across domains such as social and emotional, language and literacy, math, and science (Office of Head Start, 2015; Washington State Department of Early Learning, 2012; Teaching Strategies, 2001). Suppose children start without the foundation and identity in early science (Heckman, Pinto, Savelyev, 2015). In that case, we miss out on the opportunity to establish essential and meaningful links between the young child's prior knowledge through personal experience and emerging readiness skills (Carver, 2001; Bjorklund, 2005; Stromholt & Bell, 2017).

The National Association for the Education of Young Children (NAEYC) holds that children need high-quality learning experiences to learn essential content and science principles. Scientific reasoning in preschool-age children includes (1) scientific inquiry and (2) reasoning and problem-solving (Head Start Early Learning Outcomes Framework, 2015). Children's understanding of the world around them is one of the strongest predictors for later science learning and reading and a significant predictor of mathematics (Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010). Children's opportunities with science exploration in their early years

mark significant developmental gains and better understand scientific concepts later in life (Peterson & French, 2008; Eshach & Fried, 2005). For example, young children engage in science inquiry with clay work, fishing, farming, weaving, and computing (NRC, 2012, Stromholt & Bell, 2017). However, young children, primarily from nondominant communities, do not have the educator support to understand their exploration as science (Greenfield, Jirout, Dominguez, Greenberg, Maier, & Fuccillo, 2009).

It is no longer sufficient to provide access; instead, all children need **high-quality** early care and education (Barnett, Carolan, Squires, Clarke Brown, Horowirz, 2015; Bassok & Friedman-Krauss, 2016). Monitoring, rating, and communication are essential components to ensure high-quality care and education is accessible for all children. One approach is implementing a Quality Rating and Improvement System (QRIS) to enhance the education quality and care children receive (Vandell & Wolfe 2000). In brief, the logic model that undergirds the QRIS is this: Quality assessments inform Quality Ratings, and Quality Ratings provide information and direction for Quality Improvement, and, finally, improved quality optimizes child outcomes and school readiness (Mitchell, 2005; Zellman & Perlman, 2008; Zellman & Karoly, 2012).

In this study, ECERS-3 Item 22 Nature/science and Prek CLASS® instructional support evaluate how well an educator supports a child's emerging scientific reasoning (i.e., Greenfield et al., 2009; Center of the Developing Child, 2014; Office of Head Start, 2015; Washington State Department of Early Learning, 2012). However, while quality assessment standards evaluate and monitor the quality of education children receive, research does not discuss how LatinX educator-led classrooms fare (i.e., Hestenes, Rucker, Wang, Mims, Hestenes & Cassidy, 2019; Garvis, Sheridan, Williams & Mellgren, 2017; Early, Sideris, Neitzel, LaForett, & Nehler, 2018;

Burchinal, Garber, Foster, Bratsch-Hines, Franco & Peisner-Feinberg, 2021; Hindman & Wasik, 2013). I believe LatinX educators are cultural wealth experts because of their lived experiences (Bang 2016; Rogoff, 2003; Barajas-López & Bang, 2018; Espinosa, 2010; González, Moll, & Amanti, 2005; Yosso, 2005). A reason can be that assessments do not measure a nuanced dimension of quality that reflects cultural differences (Burchinal & Cryer, 2003; Buell, Han & Vukelich, 2016); results are aggregated at the educator level.

This study seeks to fill this literature gap by focusing on LatinX educator-led classrooms (Rosendahl, Zanella, Rist, & Weigelt, 2015). This study has three primary objectives: (1) through early science education, explore nuances in quality standards to determine the extent to which there is a global dimension of quality reflected in very different types of practices that reflect cultural differences, (2) review the literature on preschool educators' experiences and perspectives of early science education, and (3) situate on LatinX early childhood education educators' experiences and perspectives about early science education.

Results indicate, for the most part, LatinX educator-led classrooms with at least an adequate quality score (3 or above) in ECERS-3 Item 22 Nature/science had higher instructional support (IS) mean score on the PreK CLASS. Interestingly, LatinX educator-led classrooms' primary language did not influence quality standard scores in this small sample. Moreover, LatinX educator-led classrooms (3 out of 5) following a High Scope curriculum did not meet an adequate score (score of 3). Fidelity to the curriculum influences quality care and education (Maier, Greenfield, Bulotsky-Shearer, 2013; Pendergast et al., 2017). It is important to note that fidelity of curriculum was not measured in this data set. Recent research indicates that educators' education levels showed significant differences in ECERS-3 scores (Hestenes et al., 2019). Hestenes and colleagues (2019) show ECERS-3 Item 22 Nature/science (n=1063, M=2.54, SD=

1.17), in comparison, LatinX educator-led classrooms fared (n=9, M = 3.22, SD=1.72). In this study's population, LatinX educators scores varied with their level of education: Associates (n=1, M=2.00, min=2.00), Bachelors (n=7, M=2.67, SD=0.60, min= 1.00, max=4.00), and Masters (n=1, M=7, min=7.00). The sample size limits the study; however, findings show a pattern of high-quality growth as educators attain higher education achievement.

In my study, LatinX educators did not link their values, celebrations, and daily lived experiences, like cooking tortillas, as part of scientific reasoning and doing. Furthermore, they describe a need for professional development to be specific to their needs and wants. In other words, higher education degrees may not be the only pathway to enhance knowledge and practice. These findings contribute to future research efforts and implications for QRIS policy and practice by studying the following broad questions:

1. To what extent do the instruments ECERS-3 and PreK CLASS capture cultural perspectives and quality aspects of LatinX educator-led classrooms?
2. What do ECERS-3 and PreK CLASS quality measures capture about science teaching in LatinX educator-led classrooms?
3. How do LatinX educators understand and discuss their early science teaching?

Acknowledgments

I would like to acknowledge my dissertation committee for their ongoing support and encouragement. I am forever grateful to my chair, Dr. Gail Joseph, whose commitment and dedication to the early childhood education community are inspiring. She has provided me with an abundance of opportunities, and I always have something to learn. I would also like to thank Dr. Soojin Oh Park, Dr. Jondou Chen, Dr. Phillip Bell, and Dr. Wendy Thomas for their active roles as my committee members. In addition, I would like to thank Dr. Megan Bang and Dr. Mark Windschitl, who also shaped my worldview. I am forever grateful and cannot express gratitude enough as these minds shape my expertise and growth mindset. I want to thank the educators who participated in this study – without your voices, this study would not be possible. And, most of all, I would like to thank my family and friends for their continued support and encouragement. I want to thank my mother, Margarita Sandoval de Briseño, my dad Fermin Briseño Peña, my sister Maria Guadalupe Briseño Sandoval, and my two brothers Daniel Enrique Briseño Sandoval and Oscar Javier Briseño Sandoval. They were siblings to me, as much as parents - this milestone is OUR achievement, OUR work, OUR struggle, OUR voice.

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Preface

Researcher Positionality

My professional, academic, and personal experiences situate my positionality in my conceptual framework. As a first-generation LatinX American farmworker, I make sense of the world from multiple vantage points. My identities do not always align with one another. These contradictions transform my understanding and knowledge of my developing worldview. I am aware of my insider and outsider positionality when making connections with LatinX communities.

Professional and Academic Experiences

I am a graduate of the University of Washington with my MA in Human Development & Cognition, and I have my BS in Bioengineering. I am in my Ph.D. in Learning Sciences and Human Development at the University of Washington. My research interests include the relationship of learning and development in and across everyday contexts using interdisciplinary approaches and methods to child, family, and educator learning. I think and believe when educators access continuous quality improvement efforts that draw on content and process, histories, emotions, and experiences, we situate concepts as multidimensional and complex. Engaging in this approach is a way to reimagine notions while having values, histories, and (in)visibilities are at the forefront.

Personal Experiences

In the first five years of my life, I was raised and educated in Mascota, Jalisco, Mexico. The name itself is not from the Spanish language (where it translates as "pet"), instead of from Teco, "*Amaxacotlán Mazacotla*," which means the place of deer and snakes. During the Spanish conquest, it was called The Valley of Deer. The original population, the ones in charge of the current name, were Teco Indians. It is a small farm working community rooted in values, histories, and (in)visibilities.

I am the youngest of four children. My parents made a living by growing and selling cattle, pigs, chickens, and crops. At a young age, we felt the burden of responsibility. To survive, my siblings and I had to work. During this time, my dad was a permanent resident of the United States. A status he gained from the Bracero program, starting in 1942. My parents emigrated to Wapato, in the state of Washington in the country of the United States. At the age of six years old, I worked in the fields with my family. I learned English through immersion with rote practices, flashcards, and memorization. My second-grade educator, my first experience with schooling in the US, felt I was not adjusting to schooling. My perceived resistance to schooling norms prompted a home visit. *Mi amá* was encouraged to go back home. My third-grade educator felt I would belong by changing my name from Luis (*Loo-ees*) to Louis (*Loo-ee*). Simple solutions with monumental impacts for our family.

As a young adult, I understand that the best intentions fell short of my family's needs, wants, and culture. In 1995, Wapato, WA, was not as accepting or welcoming. We lived on the outskirts of town; we learned to navigate gang violence, shooting, and registered sex offenders. Now I understand the plethora of hardships my family faced. Even today, their experiences are not valued. Instead, our culture, customs, and language are a threat. My home upbringing and schooling experiences have placed me at the center of contradictions, feeling neither to belong "*here*" nor "*there*." Yet, with every day, I grow comfortable with being uncomfortable, regaining my way of being. My experiences culminate my view and sense-making process of my social, natural, and physical worlds, those shared and not shared.

Trustworthiness and Credibility

As someone who shares my LatinX participants' same background, I understand the customs and values and am aware of the cultural practices. Therefore, I can engage in authentic open conversations. I also do not belong to the Native Indigenous and East African communities; consequently, I have decided to reach out to colleagues to participate in the study. My role and that of colleagues is to be a participant-observer. My *insider* and *outsider* experiences influence my thinking throughout the study. My *insider* knowledge allows me to engage in conversations about topics requiring a relationship and trustworthiness with participants. By acknowledging my outsider knowledge, I can seek support from community members to engage in similar discussions. With that said, it takes time to foster trust and relationships, and I may not connect with Native Indigenous and East African communities. For these reasons, this study will use surveys, take field notes, transcribe group discussions, and collect participant-response to tasks to triangulate findings. I will also be member-checking findings and implications with participants. This process reduces bias and increases the trustworthiness and credibility of the study.

Chapter 1: Introduction

This dissertation is about understanding early childhood education LatinX educators' teaching and lived experience with early science. Early year educators struggle to bring meaningful opportunities to develop children's emergent scientific reasoning (i.e., Greenfield et al., 2009; Loverdige 2011; Maier, Grenfield, Bulotsky-Shearer, 2013). What is less understood is how cultural and quality aspects influence quality rating and improvement system (QRIS) policy (Garvis, Sheridan, Williams & Mellgren, 2017; Hindman & Wasik, 2013). Specifically, to what extent do assessment quality standards represent early scientific reasoning? When children first encounter science, knowing and doing science must be coincident with previous ideas and meaningful from everyday experiences to avoid negative attitudes towards science due to their decontextualized appearance (Carver, 2001; Bjorklund, 2005). Scientific reasoning occurs when the "interests of the children, parents, other educators, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives" (Edwards & Loveridge, 2011).

Professional development is an intervention charged with achieving child outcome gains (Zellman & Karolly, 2012). However, educators' struggles can be because their personal negative early science experiences influence their ability to teach science education content and process (e.g., Wilkins, 2008; Pintó, 2005; Merino et al., 2014). Educators need the time and space to observe their practice, reflect on it, and receive individualized feedback on what is working and what needs further development. To make progress, research needs to consider issues within QRIS. I use the definition of Stake (1995), “"issues are not simple and clean, but intricately wired to political, social, and especially personal contexts.” Therefore quality assessment standards and quality improvement must be locally contextualized, relevant to the child, and open to both local and global perspectives (e.g., Cajete, 2000, Bang, Warren, Rosebery & Medin, 2012; Banks, 2007; Stromholt & Bell, 2017; Zimmerman & Bell, 2014). For Seattle, Washington's youngest learners, families, and educators this means understanding federal, state, and local policies influencing their futures.

Problem Statement

Early science learning opportunities are critical for children to explore and experiment right from the start. Early year science education can introduce children to scientific concepts and stimulate scientific thinking (Ingram, 2014). Early years educators can support children in making sense of the world around them and understanding how things work (Carver, 2001; Bjorklund, 2005). Science education activities support communication skills, collaborative skills, teamwork and perseverance, and analytical, reasoning, and problem-solving skills (Banko et al., 2013). Early years science education can expand their vocabulary by using scientific terms appropriate for their age group. Encourage children to extend and embed their learning through related literacy, numeracy, and creative activities – cross-cutting concepts (Carver, 2001; Bjorklund, 2005; NRC, 2012, Ambitious Science, 2018).

Currently, LatinX children and their ways of knowing and doing science are viewed from deficit perspectives (Stromholt & Bell, 2017; Yosso, 2005). For example, "mural(s) serve to stimulate discussion and inquiry about relations of an animal to each other and their environment and reveal a complexity of inquiry that has been thought to characterize only older children." Teaching and learning through murals is one way to value multiple approaches to science (Bang et al., 2012). LatinX community's epistemic practices are placed outside of meaningful learning in institutional settings (Bang et al., 2012; Gutiérrez & Rogoff, 2003; Rosebery et al., 2010). Research shows children from Indigenous and LatinX communities bring collaboration practices into their everyday worlds into the classroom (Alcalá, Rogoff, & Fraire, 2018; Correa-Chávez, Mejía-Arauz, & Rogoff, 2015).

Research shows that access to high-quality early ECE benefits children's early development and long-term well-being (Bauer & Schazenback, 2016, Heckman, Pinto, Savelyev, 2015; Center of the Developing Child, 2014). Four-year-olds' access to early childhood education programs has increased from 28 to 68 percent in the past decade (Snyder, de Brey, & Dillow, 2019). Yet access to high-quality early childhood programs is limited, particularly for families experiencing financial hardships (Pianta, Barnett, Burchinal, & Thornburg, 2009; Barnett et al., 2015; Bassok, Fitzpatrick, Greenberg & Loeb, 2016). Given the various structures and settings of early childhood education systems, including private and publicly funded programs in centers, family child care settings, these various settings are the driver for the rise of a Quality Rating and Improvement System (QRIS) policy – an effort to enhance program quality across all environments.

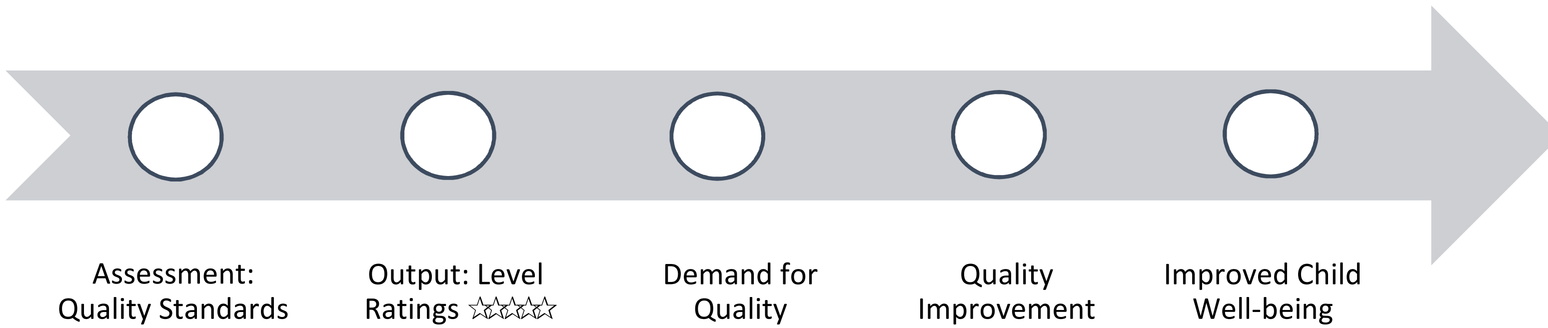
In this study, I explore what early science teaching looks like in LatinX led classrooms in the 2018-2019 Seattle Preschool Program (SPP) school year. It is important to note that all SPP programs must participate in the Early Achievers model, WA State's QRIS. See Figure 1.1 and 1.2. I believe it is essential to know how LatinX educators are doing and provide better continuous quality improvement support to enhance quality and child-wellbeing. In brief, the logic model that undergirds the QRIS is this: Quality assessments inform Quality Ratings, and Quality Ratings provide information and direction for Quality Improvement, and, finally, improved quality optimizes child outcomes and school readiness (Mitchell, 2005; Zellman & Perlman, 2008; Zellman & Karoly, 2012). School readiness is often defined as being at an expected developmental level across domains such as social and emotional, language and literacy, math, and science (Office of Head Start, 2015; Washington State Department of Early Learning, 2012; Teaching Strategies, 2001).

A quality assessment system aligns program and professional standards in Early Achievers and how programs meet those standards. Then, professional development and training are essential components to bridge coaching, workshops, technical assistance, and incentives (Zellman, & Perlman, 2008; Zellman & Karoly, 2012). Together, these drivers enhance classroom quality, educator practice, and in theory child outcomes. The Early Achievers rating levels 1-5 helps families understand their child care provider's progress in quality improvement. The early childhood education community expected families to demand enhanced quality for their children. Then, quality improvement interventions, for example, professional development, training, and coaching, are the drivers for enhancing quality care and education. Finally, with effective interventions, the Early Achievers logic model results in improved child well-being.

The stakes are high for providers in Washington State. A higher rating relates to a program's business success. Instead of families driving the demand for high-quality families' primary concerns are affordability, convenience, and programs to provide "culturally responsive care" (Ceglowski, 2004). At this juncture, policy stakeholders decide the future of young children. It is important to note that this is no longer how Early Achievers functions. For the Early Achievers logic model, in place when data collection took place, assessments are the drivers of quality ratings and continuous quality improvement, leading to improved child well-being (Soderberg, Joseph, Stull, & Hassairi, 2016). Therefore, to understand the experience of LatinX educators, we need to explore EA's "units and its relations." It is necessary to assess how the model represents standpoints across nondominant communities, including personal perspectives, social and cultural aspects of learning, and daily interactions between individuals, social groups, and context (Bakhtin, 1986).

First, when I use the term “issues” I refer to Stake’s (1995) definition, "issues are not simple and clean, but intricately wired to political, social, and especially personal contexts.” This study contributes to the field of early science education and QRIS by studying the following broad questions:

1. To what extent do the instruments ECERS-3 and PreK CLASS capture cultural issues and quality aspects of LatinX educator-led classrooms?
2. What do ECERS-3 and PreK CLASS quality measures capture about science teaching in LatinX educator-led classrooms?
3. How do LatinX educators understand and discuss their early science teaching?



Adapted from Soderberg, Joseph, Stull, & Hassairi (2016)

Figure 1 Early Achievers' Logic Mode for QRIS

Adapted from DEL (2017); HeadStart (Retrieved May 2021); DCYF (Retrieved May 2021)

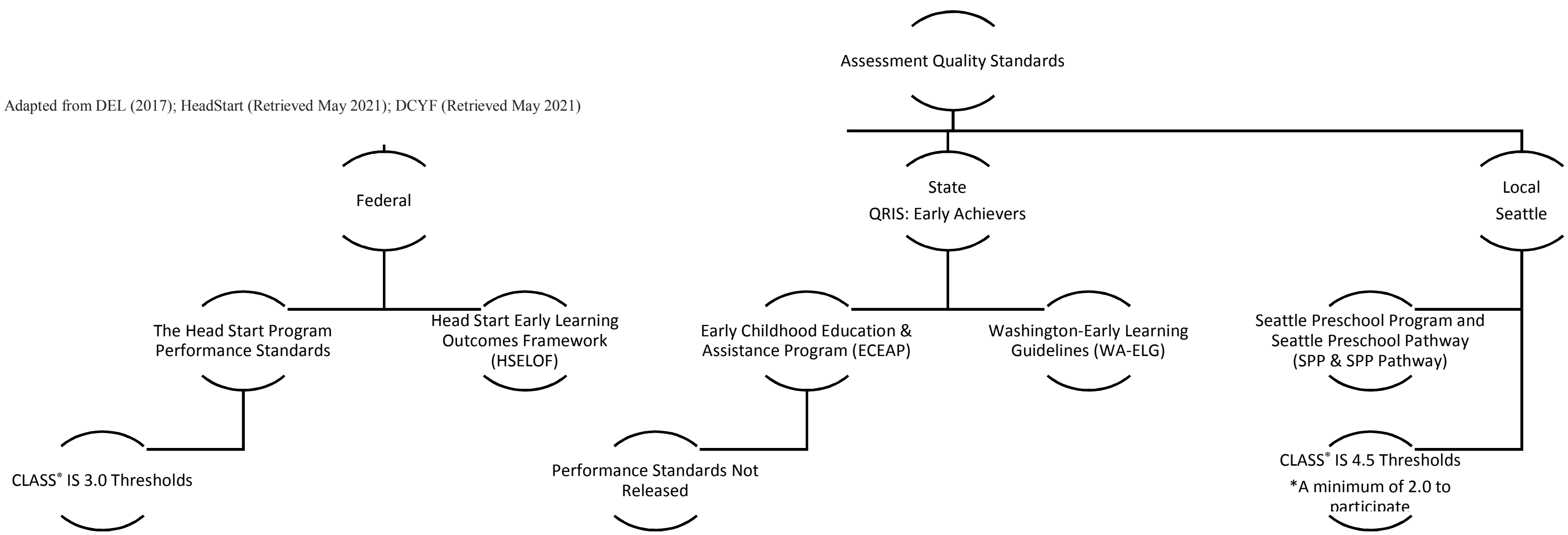


Figure 2 Federal, State, and Local Policies

At a Glance, Framing Knowledge and Rethinking Early Science

My study aims to problematize early science education by first reviewing evidence regarding early science learning and its importance. Next, I move to a state-level perspective by describing Early Achievers (EA), Washington State's QRIS policy. I also review evidence regarding early science education. Then, I describe evidence regarding ECERS-3 Item 22 Nature/science and PreK CLASS Instruction Support, mainly how LatinX led classrooms to fare. Then, pulling from this research evidence, I used Cultural History Activity Theory (CHAT) to identify the main power differences to be between (1) LatinX educators and quality assessment standards and (2) LatinX educators and quality improvement. Moreover, to explore these disturbances, I conduct a sequential exploratory design to examine how Latinx-led classrooms participate in EA fare in ECERS-3 Item 22 Nature/science and PreK CLASS instructional support.

Then, I disrupt the invisibility of LatinX educator-led classrooms by examining ECE LatinX educator-led classrooms, LatinX educators' teaching science, and lived experiences. Research shows quality assessment standard adaptations need to be with care, considering cultural issues and quality aspects based on research and proven experiences in preschool (Gravis, Sheridan, Williams, & Mellgren, 2017). "No single tool exists for measuring all important aspects of quality" (Zaslow, Burchinal, Tarullo, & Martinez-Beck, 2016). It is dangerous for nondominant children and communities when (1) there is a racial mismatch between children and educators (Heath, 1983; Nasir, Rosebery, Warren and Lee, 2006; Ceglowski, 2004; Burchinal and Cryer, 2003), (2) educator preparation for racially diverse contexts (Hardin, Lower, Smallwood, Chakravarthi, Linlin, & Jordan, 2010; Medin & Bang, 2014; Hardin, Lower, Smallwood, Chakravarthi, Linlin, and Jordan; 2010), and (3) racial inequities in school discipline (Yosso, 2005; Gilliam, Maupin, Reyes, Accavitti and Schic, 2016; Stipek, 2004) are not explored.

Otherwise, "Whose knowledge are we teaching?" and "Whose knowledge is of most worth?" (Stanley & Brickhouse, 1994).

Chapter one, section 1.1, then presents evidence regarding early science education, particularly evidence describing educator and child experience developing emerging scientific reasoning knowledge and skills. Finally, I identify that educators' understandings and discussions about teaching science are not discussed by educator race/ethnicity. In particular, findings indicate science teaching and learning occurs when the "interests of the children, parents, other educators, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives" (Edwards & Loveridge, 2011).

Section 1.2 I present evidence regarding effective early childhood programs and policies that sustain a quality early learning experience is essential (Berrueta-Clement, Schweinhart, Barnett, Epstein, & Weikart, 1984). The various structures and settings of early childhood education systems, including private and publicly funded programs in centers, family child care settings, is the driver for the rise of a Quality Rating and Improvement System (QRIS) policy – an effort to enhance program quality across all settings. I then move to review federal, state, and local/city performance standards. This background knowledge is essential because these are the drivers rating and monitoring the quality of early science education. The logic model that undergirds the QRIS is this: quality assessments standards inform quality ratings, and quality ratings provide information and direction for quality improvement, and, finally, improved quality optimizes child outcomes and school readiness (Mitchell, 2005; Zellman & Perlman, 2008; Zellman & Karoly, 2012). Then I moved to state-level QRIS in Washington State, called EA (Soderberg, Joseph, Stull, & Hassairi, 2016), and present components of quality: classroom structure and classroom process. For example, in 2018-2019, Seattle Preschool Program (SPP) used

Environment Rating Scale-Revised – Third Edition (ECERS-3; Harms, Clifford & Cryer, 2014) and PreK Classroom Scoring System (CLASS®, Pianta, La Paro, & Hamre, 2008) classroom evaluation to rate and monitor the quality of care and education.

Section 1.3 critiques ECERS-3 and CLASS®; findings indicate we do not know how LatinX educators score in these measures (Downer, López, Grimm, Hamagami, Pianta, & Howes, 2012). The final section provides a crosswalk of ECERS-3, CLASS®, Washington State Early Learning Guideline (WA-ELG), Head Start Early Learning Outcome Framework (HSELOF), and Next Generation Science Standards (NGSS). These tools measure the quality of emerging scientific reasoning.

Chapter 2 presents cultural-historical activity theory (CHAT) as my underpinning conceptual framework to evaluate the interconnectedness between *people and groups*. In this chapter, I leverage CHAT to identify tensions of early science education and argue rethinking early science education from multiple perspectives. In particular, of interest in understanding the relationships between Early Achievers, ECERS-3 Item 22 Nature/science, PreK CLASS® instructional support, and recommending future research, policy, and practice. Figure 1. Presents an overview of how these data sources influence early science education. In short, CHAT identifies the power differentials as potential sources of contradiction affecting the conceptualizing of early science education.

Chapter 3 examines the contradictions identified using a CHAT conceptual framework. I use the research gaps identified in my literature review in tandem with CHAT to identify the power differential of ECE LatinX educators in QRIS policy. The main contradictions identified are between ECE LatinX educators to (1) problematizing *what is science* and *when is science* from multiple standpoints and (2) QRIS policy - quality assessment standards. I use a sequential explanatory design to explain ECE LatinX educators' understandings and discussions of science teaching to explore these contradictions. First, I review evidence in descriptive statistics, followed by qualitative research to triangulate data sources (Stake, 1995; Yin, 2014). I use method triangulation or multiple data collection methods (Polit & Beck, 2012). In short, in this study, I use various data sources (i.e., secondary data analysis, thinking groups, and questionnaires) to investigate LatinX science teaching and learning. The triangulation of data methods increases the validity of findings and presents a breadth and depth of information to explain early science in LatinX led classrooms.

Chapter 4 evaluates secondary data analysis from the 2018-2019 Seattle Preschool Program Impact Evaluation study first to explore how LatinX led classrooms participating in EA fare in (1) ECERS-3 Item 22 Nature/science and (2) Instructional Support (IS). I use descriptive statistical methods to make sense of the data. Then, I move to thinking groups, focusing on seven LatinX educators' lived experiences and early science perspectives, regardless of EA participation. A sequential explanatory design affords multiple data resources to explain ECE LatinX teaching science related to their lived experiences. Finally, I move to the data limitations and implications.

Finally, Chapter 5 discusses the contributions to future research efforts and implications for policy and practice change in QRIS. In particular, this study addresses the LatinX educator research gap in QRIS policy, quality assessment standards, quality improvements, and early science education. In addition, future research, policy, and practice need to explore educators' race/ethnicity data to disrupt the deficit narrative, particularly from nondominant communities.

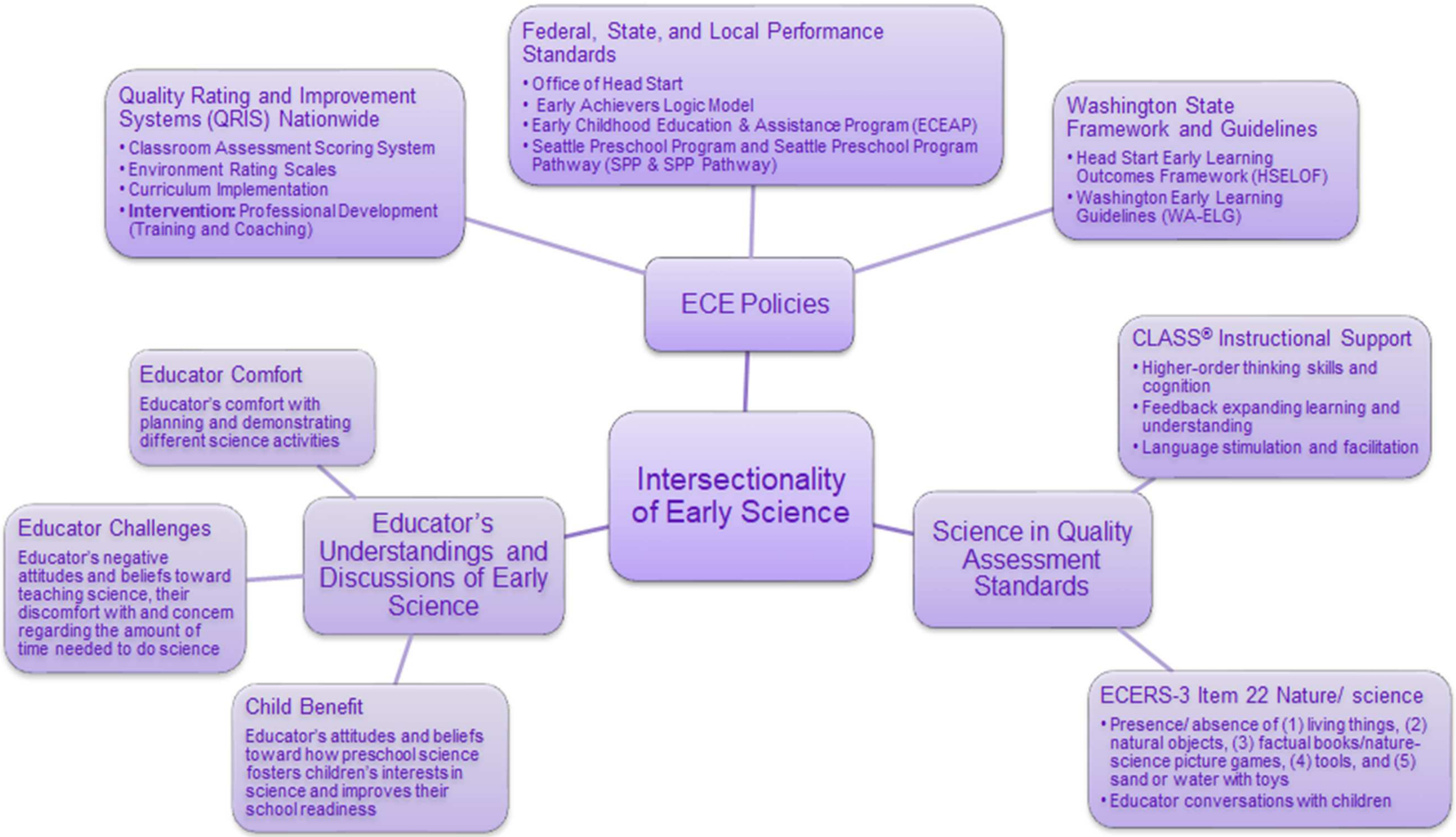


Figure 3 Framing Knowledge and Rethinking Early Science Education

Research Questions

QRIS policies are at the state and sometimes county level. Head Start programs can volunteer to participate in QRIS but are not required to because the state does not control their contracts. QRIS policy is a mechanism for states to rate and monitor program quality serving a wide range of children. QRIS policies have varying components. However, two underpinning elements are (1) quality assessment standards (e.g., aligning program and professional standards and how program meet those standards) and (2) quality improvements (e.g., professional development, coaching, workshops, technical assistance, incentives) (Zellman &; Karoly, 2012). Like QRIS, the Office of Head Start holds Head Start and Early Head Start agencies accountable for delivering high-quality CLASS thresholds. These programs are serving children ages birth to five from low-income families and promoting school readiness Studies suggest that the quality of children's day-to-day experiences in the classroom, particularly the quality of educator-child interactions, is a crucial component of early learning environments to promote children's development (Mashburn, Pianta, Hamre, Downer, Barbarin, Bryant, Burchinal, & Early, 2008).

QRIS policy is central to identifying areas of strength or need for improvement, setting smart goals, designing structures to incentivize the most vulnerable programs setting a trajectory for improvement, and monitoring progress over time (Zaslow, Tout, and Martinez-Beck, 2010). Quality improvements are an accountability tool centering on child outcomes (Zellman & Karoly, 2012). The ECE research community measures quality in many ways. Still, varying measures of quality assessment standards are grouped into two concepts: (1) structural features of ECE programs and (2) classroom processes (interaction among teachers and children) (Vandell & Wolfe, 2000). Although QRIS policy focuses on quality assessment standards and quality improvements, research needs to investigate cultural issues and differences in quality aspects in varying contexts (Garvis, Sheridan, Williams & Mellgren, 2017). An intentional focus is required because educators and young children of color and their ways of knowing and doing science are often viewed from deficit perspectives, as they can appear to be distinct from institutionally normed ways of learning science (Bang et al., 2012; others). It is essential to question whether quality assessment standards validate multiple pathways to knowledge construction (Farvis, Sheridan, Willimans & Mellgren, 2017; Hindman & Wasik, 2013).

The following research questions disrupt deficit framing and uncover cultural wealth and knowledge LatinX educators in ECE classrooms. Furthermore, LatinX educator experiences can direct high-quality professional development so that they can have positive impacts on their knowledge and believes (Hamre et al., 2012; Zaslow et al., 2010) and improve classroom quality (Early, Maxwell, Ponder, & Pan, 2017; Hamre et al., 2012; Pianta et al., 2014). In other words, high-quality professional development must center on individuals' lived experiences to affect their beliefs, knowledge, and practices positively.

First, when I use the term "issues" I refer to Stake's (1995) definition, "issues are not simple and clean, but intricately wired to political, social, and especially personal contexts." Using evidence regarding quality assessment standards, survey data, and thinking groups, I explore the following questions:

1. To what extent do the instruments ECERS-3 and PreK CLASS capture cultural issues and quality aspects of LatinX educator-led classrooms?
2. What do ECERS-3 and PreK CLASS quality measures capture about science teaching in LatinX educator-led classrooms?
   a. What are the characteristics of LatinX educators?
   b. What factors affect an educator's score in ECERS-3 Item 22 Nature/science?

c. How many educators meet a 3.0 threshold mean in PreK CLASS instructional support?

d. To what extent do the instruments ECERS-3 and PreK CLASS capture cultural issues and quality aspects of LatinX educator-led classrooms?

e. What do ECERS-3 and PreK CLASS quality measures capture about science teaching in LatinX educator-led classrooms?

f. How do LatinX educators understand and discuss their early science teaching?

3. How do LatinX educators understand and discuss their early science teaching?

g. Where are some places educators learn about science?

h. Who do educators learn about science from?

i. What professional development and training do educators need?

j. How do educator comfort, educator challenges, and child benefit affect educators' self-efficacy and competency (i.e., knowledge, values, beliefs)?

I hypothesize that the following empirical propositions (Yin, 2003) will emerge. First, research suggests that tools validated in a context do not necessarily apply to another context, and this assumption is problematic for the high-quality care and education children receive (Garvis, Sheridan, Williams & Mellgren, 2017). In other words, "no single tool exists for measuring all important aspects of quality" (Zaslow, Burchinal, Tarullo, & Martinez-Beck, 2016). Research shows quality assessment adaptations need to be done with care, considering cultural issues and quality aspects based on research and proven experiences in preschool (Garvis, Sheridan, Williams & Mellgren, 2017). Moreover, educators and children's lived experiences develop essential sense-making practices, often overlooked, outside of institutionalized systems (Stromholt & Bell, 2017; Yosso, 2005). Therefore, educator race

/ethnicity may play a significant role in understanding classroom quality, professional development, and child outcomes. Second, by evaluating evidence regarding quality assessment standards, I predict findings are aggregated by race/ethnicity. Therefore, I identify a research gap in QRIS policy, quality assessment standards, which has yet to consider cultural issues and differences in understanding quality aspects.

It is essential to consider that there are affordances of quality assessment tools when evaluations consider cultural differences. For example, ECER-3 Item 22 Nature/science and PreK CLASS instructional support measure the materials present/absent in a classroom, and educators facilitate (1) scientific inquiry and (2) reasoning and problem-solving. Following this logic, I predict LatinX ECE educators fare well compared to evidence regarding quality assessment standards. Moving to educator self-efficacy and competence, I expect LatinX educators to fare similar to evidence regarding educator comfort, educator challenges, and child benefit. I believe science education is essential for children and struggle to enact practices in their day-to-day teaching (e.g., Wilkins, 2008; Spektor-Levy, Baruch, & Mevarech, 2013; Tu & Hsiao, 2008). Educators' struggles can be because their negative early science experiences influence their ability to teach science education content and process (e.g., Wilkins, 2008; Pintó, 2005; Merino et al., 2014). I also predict LatinX educators are unsure of how to culturally broker (Ishimaru, Salvador, Lott, Williams & Tran, 2016) their funds of knowledge to enhance their science teaching. Cultural brokers play a critical role in bridging the racial, cultural, linguistic, and power divides.

1.1 Young Children are Scientists!

The following section presents early science learning and its importance. It is followed by how young children are doing in early science and the consequences of young children not having the foundations in early science.

1.1.1 Preschool Scientific Reasoning: Ways of helping children to learn and do science

What is science in preschool? Young children are scientists. Scientists in the crib explore their interests, curiosity, and wonder about the social, physical, and natural world. Science education can begin with preschools, toddlers, and even infants. Infants a day old distinguish among unfamiliar sounds in their native language better than older infants and adults (Moon, Lagercrantz, Kuhl, 2013; Kuhl, 2004). Younger children generate more alternative uses for artifacts than older children (Defeyter & German, 2003). Preschool children perform better than adults at grasping unusual causal structures (Gopnik, 2010). By analyzing the use of two blocks to make a blicket detector function (light up), Gopnik (2010) shows that "four-year-olds were better than adults at grasping unusual causal structure." Adults relied more on their prior academic knowledge, causing them to believe that a device functions only in one way rather than observing and analyzing facts that were in front of them. Children in this study use their emergent scientific reasoning by creating hypotheses and asking why questions to learn about the world, much like scientists do.

"Scientists and science [educators] agree that science is a way of explaining the natural world… science is both a set of practices and the historical accumulation of knowledge" (NRC, 2012). Science is inquiry-driven (Bybee, 2011; Peterson & French, 2008). Young children make sense of the social, natural, and physical worlds in meaningful and sophisticated ways before entering kindergarten (Cajete, 2000; NRC, 2012). Young children engage and do science by exploring their surroundings, discussing the causes and consequences of the phenomena they observe, and their lived experiences with varied exposures to activities. For example, young children engage in science inquiry with clay work, fishing, farming, weaving, and computing (NRC, 2012, Stromholt & Bell, 2017). For example, for preschoolers, we know that scientific reasoning refers to the emerging ability to develop (1) scientific inquiry and (2) reasoning and problem-solving (HSELOF, 2015; Bybee, 2011)).

Consider, for example, preschool children know about the differences between animate and inanimate objects (Gelman & Opfer, 2002). Children can predict that animate objects can move by themselves and inanimate cannot (Massey & Gelman, 2004). Furthermore, children distinguish between living and non-living. For example, children know that plants and animals can grow and heal and artifacts cannot (Backsheider, Shatz, Gerlman, 1993). Moreover, even though germs are invisible to the naked eye, children can explain (1) germs can cause illness and (2) germs transmit through physical contact (Kalish, 1996). Children grasp and describe unusual causal structures (Gopnik, 2010). When children play with a box-type structure, not behaving as what one would expect. Children explore the toy to reason and problem solve by making predictions and correcting their working understanding of how the object could work as new information is grasped. However, when this box-type structure is presented to adults, they cannot problem solve and make new predictions with the information at hand. Adults are only relying on their current understanding of how an object must work. Whereas preschool children problem solves and reasons with the information at hand to make predictions. Pulling from this research, children need high-quality learning experiences to learn essential content and science principles.

Research shows that children's experiences before kindergarten entry correlate with the degree of cognitive development and school readiness (Ramey & Ramey, 2017; Chapin, 2006). Children's understanding of the world around them is one of the strongest predictors for later science learning and reading and a significant predictor of mathematics (Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010). Children's opportunities with science exploration in their early years mark significant developmental gains and better understand scientific concepts later in life (Peterson & French, 2008; Eshach & Fried, 2005). Children engage in more complex science thinking across place and setting than often assumed by adults (Legare & Lombrozo, 2014; Gopnik, 2010; Stromholt & Bell, 2017).

Young children of color and their ways of knowing and doing science are often viewed from deficit perspectives, as they can appear to be distinct from institutionally normed ways of learning science (Bang et al., 2012). Let us consider when a child from a nondominant community is asked: *"Who's a scientist?"* Children describe a white man in a lab coat even when a black child's parent is a scientist. Children still see science as a bounded image (Sleeter, 1996). We know this not to be accurate; for example, "mural(s) serve to stimulate discussion and inquiry about relations of an animal to each other and their environment and reveal a complexity of inquiry that has been thought to characterize only older children." Teaching and learning through murals is one way to value multiple approaches to science. Young children, primarily from nondominant communities, do not have the educator support to understand their exploration as science (Greenfield, Jirout, Dominguez, Greenberg, Maier, & Fuccillo, 2009). Effective educator-child conversations cultivate children's emerging ability to develop knowledge about the natural and physical worlds, learn scientific skills and methods (Bybee, 2011; Greenfield et al., 2009; Edwards & Loveridge, 2011).

Designing meaningful opportunities for educator-child science engagement is a great concern for educators and policymakers alike (Berrueta-Clement, Schweinhart, Barnett, Epstein, & Weikart, 1984). Evidence regarding early childhood education experiences is important for supporting gains in science and gains in other disciplines, such as literacy, language development, and math (i.e., Greenfield et al., 2009; Peterson & French, 2008). Stakeholders and education leadership use guidelines to inform the early learning community about early learning benchmarks. Policies support educators to enact meaningful content instruction, and as a result, a child has more productive early learning experiences (Kagan, 2013). However, despite guidelines elevating the importance of a child's early science education, students' opportunities to engage in science education are disproportionate to other domains in early childhood classrooms (La Paro, Hamre, Locasale-Crouch, Pianta, Bryant, Early, & Burchinal, 2009).

We must situate science in context and history, where places and artifacts represent local and worldwide community epistemic practices (Zimmerman & Bell, 2014). A transformative learning environment creates education systems, cultivating just, sustainable, and thriving communities. The goal is to create a thriving community of learners who are "united in a shared experience of trying to make meaning of their lived experience" (Elias, 1997). Educators provide learners with opportunities to participate in doing and being a part of scientific discourse effectively. Discourse involves assessing beliefs, feelings, and values (Cranton, 2006). However, there is still much to learn about how children are doing in early science. An important goal for the conceptualization of early science is a better understanding of educator-child conversation and educator expectations for young learners. Moreover, I evaluate some of these concepts by focusing on three dimensions of science learning in preschool classrooms: (1) educator comfort, (2) educator challenges, and (3) child benefit.

1.1.2 Evidence Regarding Science Learning in Preschool Classrooms

What is science in preschool, and what do teachers have to know to empower children? (Andersson & Gullberg; 2012). Educators need to leverage what they know about each child's experiences to make personal connections to science content instruction (Penuel, Fishman, Yamaguchi & Gallagher, 2007; Nasir & Cooks, 2009, Manz & Renga, 2017; Bricker & Bell, 2008). For example, murals, art, dance, and song storytelling mediums elicit higher-order thinking and understanding but weave the interconnectedness across places (Cajete, 2000; Medin & Bang, 2010). Young learners bring a range of lived experiences, ideas about the natural and designed world, and linguistic resources (Reiser, Fumagalli, Novak & Shelton, 2016; NRC, 2015). ECE children learn a stunted view of science before entering elementary school (Early, Iruka, Ritchie, Barbarin, Winn, Crawford, Frome, Clifford, Burchinal, Bryant, & Pianta, 2010). The need to transition to meaningful science education is essential, rather than predicting and controlling practices (Cajete, 2000), leading to the homogeneous conceptualization of science (McDermott & Webber, 1998).

First, in science education's "right" process, WE do not acknowledge science as an activity socially and historically conditioned from white empiricist perspectives. For example, "Alaskan indigenous perspectives often emphasize relationships between people and other living and non-living entities ("how to"), whereas western science tends to emphasize facts ("what is")" (Cochran, Huntington, Pungowiyi, Tom, Hungtinton, Maynard, & Trainor, 2013). Research shows "science is an activity socially and historically conditioned, conducted by scientists who have different strategies that involve creative intellectual process, empirical validation and critical selection, and through which a changing temporary and relative knowledge is built" (Merino, Olivares, Navarro, Ávalos, & Quiroga; 2014).

When educators succeed, our children grow, and we all benefit. However, it is important to note; educators require support to enact cross-cutting teaching practices across concepts (NGSS, 2015) and ambitious science education rooted in equity and quality (NRC, 2012). I challenge us to rethink science education as constructed from several sources, including personal perspectives, social and cultural aspects of learning, and daily interactions between individuals, social groups, and context. In this way, we counteract the dangers of a single image or story of science education representing *those* in power doing the construction from their useful sociopolitical ways from *those* doing the construction (Rudolf, 2001).

There is a growing body of literature (from the 10 reviewed) evaluating early science education. Only 10 (out of 47) empirical studies evaluate "science" linked with "attitudes and beliefs," followed by "preschool." The inclusion criteria require studies to evaluate science in preschool classrooms, be published within the last 20 years, and be peer-reviewed articles. "Preschool" is a critical inclusion/exclusion criterion, as there is less research focusing on infant and toddler educators' perspectives, attitudes, and beliefs. Despite the prevalence of science education research in elementary, middle, and high schools, these studies will not be considered due to the subtle but relevant nuances across educators' educational backgrounds. To elaborate, an educator in ECE must hold a High School/GED, Associates' (AA), Child Development Associates' (CDA), or B.A. to teach, whereas higher education requires an educator preparation certificate. The 10 research studies vary in methodological frameworks: quantitative studies, including case studies, listening/thinking groups, and mixed methods. Due to the low count of studies within the United States (reviewed sources from Midwest, Georgia, Florida, and New Jersey), the literature review draws on studies taking place in; Chile, New Zealand, Turkey, and Southern Australia**.**

Several studies (from the 10 reviewed) find positive relationships between educators' science education self-reported competence on classroom instructions and materials, while others show mixed, negative, or null findings. Educators self-reported competence examined educator comfort, challenges, and child benefit as essential concepts to further our understanding of early science. Pajares (1992) argues beliefs are underpinned by personal lived experiences and are difficult to change. Windschitl and colleagues (2007), based on their research into the scientific method, argue educators' belief dominates the conceptual frameworks that both novice and experienced educators use to design investigative science experiences for students. Moreover, Palmer (2006) argues for three concepts underlying self-efficacy. The first, cognitive content mastery, is success in understanding science content. The second cognitive pedagogical mastery is success in understanding how to teach. Finally, simulated modeling is when educators learn about classroom practices through role-playing.

Educator comfort measured educators' comfort with and enjoyment of planning and demonstrating activities across science content areas. Educator challenges measured educators' competence toward teaching science, including their challenges and concerns regarding their ability and science knowledge to engage in science education. Finally, child benefit measures educators' competence regarding whether science is developmentally appropriate for preschoolers, fosters preschoolers' interest in science and helps improve different school readiness skills. Pulling from this research, it appears that these interrelated factors influence educators' feelings regarding their support of children's scientific learning. See Table 1.4 below. Refer to Appendix B for a detailed table describing participants, study type, and measures used.

Table 4 Evidence Regarding Educator and Child Early Science Teaching and Learning

	Findings			
Citation	**Educator Comfort**	**Educator Challenges**	**Child Benefit**	**Study Design?**
Tu, 2006	Mixed	Negative	Negative	Quantitative
Tu & Hsiao, 2006	Mixed	Negative	Positive	Quantitative
Greenfield et al., 2009 *	Mixed	Mixed	Positive	Mixed
Nayfeld et al., 2011	n.a.	n.a.	Positive	Quantitative
Edwards & Loveridge, 2011*	n.a.	Mixed	Positive	Case Study
Maier, Greenfield, Bulotsky-Shearer, 2013	Mixed	Mixed	Positive	Mixed
Merino et al., 2013	n.a.	Negative	Negative	Mixed
Fleer & Gomes, 2014	Positive	Negative	Positive	Case Study
Aslan, Tas & Ogul, 2016 **	Positive	Positive	Positive	Quantitative
Pendergast et al., 2017 ***	Positive	Positive	Positive	Quantitative

To overview, the research discusses that preschool educators' engagement to be unrelated to science activities (86.8%), 4.5% of the activities were related to *formal sciencing* (educators' planned activities), and 8.8% of the activities were related to *informal sciencing* (classroom organization to maximize scientific interactions and exploration). The study finds there is a "need to expand [educators'] knowledge of science to increase their familiarity and comfort level and integrate science more rigorously into their classroom." Educators can enhance their engagement with science to tap into their lived experiences to facilitate emerging scientific reasoning. "Preschool educators need to expand their knowledge of science … to increase their familiarity and comfort level and to integrate science more rigorously into their classrooms." In other words, emerging scientific reasoning educator involvement is necessary across a child's day-to-day experience, and a shift from sharing knowledge to a co-constructing understanding with learners is essential.

Moreover, research shows a challenge for educators to carry out scientific reasoning is their "low self-efficacy in science and time-management issues as two possible barriers for why preschool educators may have difficulty teaching science" (Greenfield et al., 2009). Likewise, educators' discomfort with not having sufficient scientific knowledge prevents them from exploring science in the classroom with young learners (Merino, Olivares, Navarro, Ávalos, & Quiroga; 2014; Tu, 2006; Tu & Hsiao, 2008; Maier, Greenfield, & Bulotsky-Shearer, 2013). Regardless, educators who are unsure or have misconceptions of what science still supports children's working theory around the nature of science, whether they are aware of it or not (Edwards & Loveridge, 2011).

During thinking groups, educators believe science education begins in the early years (Greenfield et al., 2009). Educators believe very young children investigate and participate in the inquiry and scientific activities influencing long-term attitudes towards science education (Pendergast, Liberman-Betz, & Vail 2017; Maier, Greenfield, Bulostky-Shearer, 2013). "Educator[s'] knowledge bases increased by the interests of the children, parents, other educators, and broader community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives" (Edwards & Loveridge, 2011). "Sciencing attitude is likely to maximize the scientific learning opportunities of young children" (Fleer & Gomez, 2014). In brief, educators feel like their funds of knowledge are not valuable (i.e., González, Moll, & Amanti, 2005; Gutiérrez & Rogoff, 2003; Rogoff, 2003; Yosso, 2005, Nasir, Rosebery, Warren and Lee, 2006) when in reality, they are experts because of their lived experiences (Bang 2016; Rogoff, 2003; Barajas-López & Bang, 2018; Espinosa, 2010; González, Moll, & Amanti, 2005; Yosso, 2005).

1.1.3 Factors Relating to Educator Understanding and Discussion of Early Science Teaching

Taken together, the literature reviewed in Table 4; researchers investigate multiple data sources to explore educators’ understandings and discussion of early science teaching. It appears that these factors influence educators’ regard to supporting children’s scientific learning.

However, while these researchers report educator demographics, fidelity to curriculum, professional development, teaching experience, gender, and the highest level of education, for the most part, investigations did not report how these factors relate to educators' understanding and discussion of early science teaching. See APPENDIX C for a summary of findings.

First and foremost, taking together the literature in Table 4, there is an underlying foundation that the materials and educator-child conversation are essential to understanding and doing science. Specifically, Nayfeld and colleagues (2011) discuss "that children are unlikely to benefit fully from the presence of science tools through autonomous exploration alone because they do not go to the science areas to use these materials *on their* own." The authors discuss the importance of educators' scaffolding, connecting to children's prior knowledge and learning, and extending children's knowledge and exploration during free play. Similarly, Tu's (2006) investigation maps preschool educators' engagement to be unrelated to science activities. Tu and Hsiao (2008) investigate educator-child verbal interaction and discuss educators are interacting "most often in the art area (24.8%), and the sensory play (19.3%), and science (0.3%)." Educators are more likely to use more praise, acknowledgment statements, and closed questions without professional development.

Similarly, Merino and colleagues (2013) show "directive role" and do not "reinforce (does not consider) verbalizations and observations of the children that are not going on the expected path ("correct") and promote the repetition of the ones considered right." Whereas Edwards & Loveridge (2011) discuss "participants' knowledge bases increased by the interests of the children, parents, other teachers, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives." Other researchers discuss the importance of educator attitudes and beliefs as essential to enhance educator-child science-related conversations (i.e., Greenfield et al., 2009; Maier, Greefield, Bulotsky-Shearer, 2013; Pendergast et al., 2017). Pulling from this body of literature, materials, and educator-child conversations are fundamentals to evaluate quality early science teaching (CLASS®, Pianta, La Paro, & Hamre, 2008; ECERS-3; Harms, Clifford & Cryer, 2014).

Next, nearly all investigations collected educator demographics. Maier and colleagues (2013) are the only sources that associated educator demographics to their perspectives toward teaching science to young children. Through exploratory factor analyses, the investigation "identified three distinct and reliable factors that shared common variance and reflected similar attitudes and beliefs towards teaching science: teacher comfort with teaching science benefit of science of children and challenges when teaching science." Further, the researchers indicate findings to be generalizable and invariant across different subgroups (ethnicity, education level, and experience level). With that said, Maier and colleagues (2013) report that while racial background did not influence educator comfort and child benefit, it influenced educator challenges. They indicate that items in educator challenges "may potentially be assessing a diverse set of challenges associated with teaching science that may or may not be experienced by different teachers."

While Maier and colleagues (2013) indicate generalizability across different subgroups (ethnicity, education level, and experience level), Aslan, Tas, and Ogul (2016) indicate educators with teaching experience of 10 years or more had a higher level of science teaching self-efficacy beliefs. They also suggest that in-service educators having science, technology, engineering, and science coursework in high school had more science teaching efficacy (Aslan, Tas, and Ogul, 2016). At the same time, the other resources (8 out of 10) did not explore how educator demographics correlate to their findings. However, it is noteworthy to highlight that Maier and colleagues (2013) were the only sources measuring the fidelity of the science curriculum. They report an internal consistency was adequate across almost all subgroups: ethnicity (Black/African-American, Hispanic/Latino, White), an education level (DCDA/associate's degree, bachelor's degree, master's/doctoral degree), and experience level (three or fewer years [there of fewer years of teaching] or experience [four or more years of teaching])." Educators who implement a science curriculum reported significantly higher Educator Comfort and Child Benefit scores at the end of the year compared to the beginning of the year, but no difference between pre-and post-scores. Regardless, researchers can differentiate between educators engaged in science training, which can help increase the likelihood of educators changing their practices as envisioned by professional development.

Moreover, six out of ten resources discussed how professional development relates to educators' understanding and discussion of early science teaching. First, professional development is proven to improve child outcomes (Zellman & Karoly, 2012). Thus, it is noteworthy to mention many terms that describe professional development approaches. For example, "communities of learning/practice," "peer coaching," and "reflective supervision" highlight the role of continuous quality improvement. Second, Greenfield and colleagues (2009) discuss significant differences across school readiness domains between children in the Early Childhood Hands-On Science (ECHOS) classroom and children in the control classrooms during an early science program intervention. Finally, it is noteworthy that ECHOS provides resources for educators to enhance their confidence with teaching science, help them adjust to their classroom schedules, and teach science by integrating multiple school readiness domains within science.

Nayfeld and colleagues (2011) discuss it is unlikely that children will benefit from the presence of science materials through self-exploration alone because they do not go to the science area on their own. Therefore, it is science tools that require an introduction. Their intervention requires an adult, through two circle time sessions, to discuss with children about a balance scale, how an object can be used, and provide information about the relative weight of the object. Children used knowledge learned through their interactive discussions as a basis for further exploration during free play. With this foundation in place, educators can use instructional support practices to guide children to understand and do science. While the authors do not implement this intervention with educators, their research shows implications for continuous quality improvement. Edwards & Loveridge (2011) extend our understanding that effective continuous quality improvement takes place when it develops an educator's knowledge base - "their interests and knowledge valued by the associated learning community (children, parents, and the wider community members).

Maier and colleagues (2013) discuss correlations between the Preschool Teacher Attitudes and Beliefs towards science teaching questionnaire (P-TABS) factor scores and fidelity to the science curriculum. The changes were examined in P-TABS factor scores for Educator Comfort, Child Benefit, and Educator Challenges using paired sample t-test, pre-training (beginning of the year), and post-training (end of the year). Their findings indicate that educators implementing the science curriculum have higher Educator Comfort and Child Benefit scores at the end of the year but no change for Educator Challenges. Therefore, the authors go on to discuss that "professional development that identifies and addresses less positive attitudes and beliefs towards science teaching may help increase the likelihood of teachers changing their classroom practice." Pendergast and colleagues (2017) using P-TABS broaden our understanding of professional development and its influences on educators understanding and discussing early science teaching. The researchers find that educators who participate in science-related professional development activities are more likely “to enjoy conducting science activities with their students,” “to feel comfortable planning and demonstrating activities related to life sciences,” and “to feel comfortable planning and demonstrating classroom activities related to physical and energy science” as compared to educators with no science-related professional development within the past three years. In addition, educators who participated in science-related professional development activities are more likely to agree that “science-related activities improve preschooler’s math skills and social skills.” Like Maier and colleagues (2013), Pendergast and colleagues (2017) found no “differences between participants engaging in science-related professional development on perceived challenges faced in teaching.” In short, there are many interrelated factors influencing educator’s understanding of their early science teaching and learning.

This body of literature indicates that the presence/absence of materials, educator instruction, educator background, values, attitudes, and beliefs influence their understanding of science teaching. Yet, pulling from this literature review, investigations have not explored LatinX educators in early science education. For example, what do assessment quality standards measure about early science teaching, materials, and conversations, in LatinX led classrooms? How do their primary language, education level, and professional development opportunities influence their understanding of their science teaching? Are there cultural values and stories influencing their teaching and learning of early science?

1.2 Evidence Regarding Continuous Quality Improvement in QRIS

In section 1.1, I problematized historical and current definitions of early science education and discussed emerging scientific reasoning and educators' competence with teaching science. The context of quality standards and continuous quality improvement are essential components to consider when exploring Washington State educators' understanding and discussion of early science teaching. Therefore, section 1.2 overviews evidence regarding quality rating and improvement systems (QRIS) as essential to assessing, improving, and communicating a quality rating level to families. I then overview Early Achievers, Washington State's QRIS, and situate assessment quality standards as the drivers for child learning gains and development.

1.2.1 *The Importance of QRIS policy*

Nationwide, federal, state, local, and tribal communities strategize to provide ECE care and education for all children (Barnett, 2003; Barnett & Friedman-Krauss, 2016; Cascio & Schazenbach, 2013; Currie & Neidell, 2007). As a result, families across the United States rely upon a system of early education and care. To understand LatinX educators' lived experiences, we need to have context. First, we need to consider that there are different types of policies driving ECE. Next, we need to know the number of LatinX educators in ECE participating in QRIS. Finally, we also need to understand where early science is addressed in QRIS.

First, federal policies apply to everyone in the United States. In addition, each state can have its systems of policies. Similarly, localities can have their systems of policies. For example, providing high-quality early care and education has been an important policy goal at the federal, state, and local levels (Barnett, 2003; Barnett & Friedman-Krauss, 2016; Cascio & Schazenbach, 2013; Currie & Neidell, 2007).

In Washington State, the ECE community uses federal, state, and local policies. Each locality follows the federal, state and can develop its policies. The Early Start Act of July 6, 2015 states that “beginning August 1, 2016, licensed child care and early learning providers offering services to children and families that qualify for Working Connections Child Care subsidies must be enrolled in Early Achievers to maintain subsidy authorization.” As of August 18, 2021, the Washington State Department of Children, Youth and Families reports 3977 programs participating in EA out of 43654 (retrieved: https://www.findchildcarewa.org/#).

Second, after reviewing the quality compendium (Quality Compendium, 2021) and DCYF (retrieved: EA-Dashboard.pdf (wa.gov)), data is not disaggregated at the educator level. Nevertheless, we understand the landscape of educators participating in QRIS by referring to local data. For example, in the Seattle Preschool Program Evaluation report 2018-2019, 9 LatinX educators led classrooms out of 85 educators. All 85 educators were part of programs participating in Washington State’s QRIS policy or Early Achievers.

Finally, in EA, the quality assessment standards recognize early science strengths and encourage growth in the following areas: interactions and environments and curriculum and staff support. Moreover, programs in Washington State are to follow The Head Start Early Learning Outcomes Framework (HSELOF), birth through preschool, and Washington State Early Learning Guidelines (WA-ELG), birth through third grade, respectively. In addition, in the K-12 education system, the Next Generation Science Standards (NGSS, 2015) and Ambitious Science Teaching (AST) guide educators' teaching and practice.

Nugent, Kunz, Rilett, and Jones (2010) discuss that educators developed more positive attitudes towards STEM and increased their self-efficacy after receiving STEM professional development.To enhance educator mastery to support children’s exploration as science, especially nondominant children, research, practice, and policy should understand the structures evaluating early science education and quality improvement. Unfortunately, we do not have data disaggregated at the educator level to characterize LatinX educator-led classrooms' strengths and encourage growth. Not having this data is an issue to supporting child-well being across readiness domains, specifically early science education

1.2.2 At a Glace, QRIS History

QRIS is a policy that emerged in 1998 when Oklahoma enacted its "Reaching for the Stars" program (Neugebauer, 2009). In 2005, fewer than ten states had adopted a QRIS; as of the beginning of 2021, 44 states have adopted a QRIS infrastructure in assessing and monitoring quality (Quality Compendium, 2021). Second, Nationwide, States and Sovereign Nations implement a Quality Rating and Improvement System (QRIS) to elevate the education quality and care children receive (Vandell & Wolfe 2000). Moreover, Sovereign Nations, as recipients of federal grants, participate in QRIS systems. Integral components of a QRIS model include assessing, improving, and communicating a quality level through a rating system (Mitchell, 2005). In addition, QRIS provides families and the government with precise data about where to invest early care and education dollars for making progress. States' QRIS systems have varying components, but two underpinning elements are present across states.

Nationwide, federal, state, local, and tribal communities strategize providing ECE care and education for all children (Barnett, 2003; Barnett & Friedman-Krauss, 2016; Cascio & Schazenbach, 2013; Currie & Neidell, 2007). It is no longer sufficient to provide access; instead, all children need high-quality early care and education (Barnett et al., 2015; Bassok et al., 2016; Early et al., 2005). Given the fragmented structure of state ECE systems, including private and publicly-funded programs in centers, schools, and home-based settings, relatively few policies have attempted to improve the quality of care. The emergence of state Quality Rating and Improvement Systems (QRIS) enhances program quality across ECE sectors.

1.2.3 At a Glance, Washington State's QRIS – Early Achievers

Most of the research to date on QRIS has focused on the validity of QRIS ratings to determine whether higher-rated programs provide higher-quality experiences for children (Hestenes et al., 2015; Sabol, Hong, Pianta, & Burchinal, 2012; Sabol & Pianta, 2015). In addition, research provides some evidence to suggest that QRIS quality improvement supports are associated with quality improvements (e.g., Boller et al., 2015; Yazejian & Iruka, 2015). More recently, evidence regarding the efficacy of the combination of incentives and supports for quality improvement led to improvements (Bassok, Dee, & Latham, 2019). Herbst (2018) finds that QRIS implementation increased the supply of childcare talent. However, there is little understanding of whether QRIS implementation enhanced structural and process quality. For QRISs to function as designed, it is essential to evaluate how quality assessments standards adaptations consider cultural issues and differences in quality aspects to inform quality improvement efforts.

A QRIS logic model is a mechanism for states to improve quality in programs serving a wide range of children. Research and best practice provide programs with standards leading to various frameworks across states. For example, Washington State's QRIS logic model is called Early Achievers. Early Achievers' objectives are consistent with the overarching purpose of QRIS. The primary aim is to help early learning professionals offer high-quality childcare supporting children's learning and development (Soderberg, Joseph, Stull, & Hassairi, 2016). First, assessment quality standards drive providers' rating levels; by evaluating classroom quality, educator practice, and child outcomes. In Early Achievers, Washington's quality rating and improvement system, there are five assessment quality standards: (1) child outcomes, (2) interactions and environment, (3) curriculum and staff support, (4) family engagement and partnerships, and (5) staff professionalism. See Figures 2 and 3.

Early Achievers policy evaluates early science education with assessment quality standards. For example, educators refer to the federal Head Start Early Learning Outcomes Framework (HSELOF) and local Washington State Early Learning Guidelines (WA-ELG). Another way to assess science is through the Early Childhood Education Rating System – Third Edition (ECERS-3), Classrooms Assessment Scoring System (CLASS ®), and curriculum meeting developmental guidelines (i.e., HighScope, Creative, etc.).

1.2.4 Quality Assessment Standards: Classroom Structure and Process

There are many ways of evaluating classroom quality, educator practice, and child outcomes. The ECE research community groups these variations into *structural features* and *classroom processes*. Such classroom quality components are essential for educator improvement; however, they do not directly measure children's learning gains (Child Trend, 2010). Monitoring, rating, and communication are essential components to ensure high-quality care and education is accessible for all children. Specifically, for those most in need, Head Start serves low-income children and their families primarily. In addition, head Start estimates that approximately 30% of their enrollees are English language learners (Office of Head Start, 2014). In other words, English is not their home language. Therefore, classroom quality evaluations measure the classrooms' supports and can offer insight into child outcomes, but classroom quality evaluations do not correlate to child learning gains. Equally important is considering how *structural features* and *classroom processes* relate to the quality of nondominant communities. There is some evidence to show how the structural component of quality affects child outcomes through classroom processes (Justice, Mashburh, Hamre, & Pianta 2008). Structural features are interesting to policymakers and practitioners as they are easy to regulate (e.g., ratios, class size, length of day). The Early Childhood Environment Rating Scale—Third Ed. (ECERS-3; Harms, Clifford & Cryer, 2014) describes how an educator engages in content with process and materials. Structural characteristics of classrooms are essential prerequisites for excellent classroom quality.

Next, the Classroom Assessment Scoring System (CLASS®, Pianta, La Paro, & Hamre, 2008) evaluates educator-child interaction. As a result, the *classroom process* is "more predictive of child outcomes than structural indicators such as staff to child ratio, group size, cost of care, and even type of care, for example, childcare center or family childcare home" (Whitebook, Howes & Phillips, 1990). For that reason, a shift from *what* happens in classrooms (e.g., quantity, culturally relevant, and developmentally challenging materials) towards coupling *what* (materials) and *how* (content instruction) support children's learning gains, a more comprehensive approach. In summary, ECERS-3 and CLASS® both describe the quality of learning in the classroom, content with process, and materials. For example, in ECERS-3, an educator uses and talks about nature/science materials with children to co-construct understanding. In CLASS®, to achieve a gain in Instructional Support (IS) – a substantial amount of learning, self-reflection, and practice must occur. Without attending to the Emotional Support and Classroom domains of teacher-child interactions, Instructional Support gains are unlikely. An intentional focus on analysis and reasoning (e.g., why and how questions), creating, integrating concepts and previous knowledge, and connecting learning to the real world related to students' lives matters.

1.2.5 Use of ECERS-3 and PreK CLASS® and Science Education

As aforementioned, it is critical to evaluate the quality children receive as we know science exploration in their early years makes significant developmental gains and better understands scientific concepts later in life (Peterson & French, 2008; Eshach & Fried, 2005). We also know children from nondominant communities are most likely to miss out on emerging scientific reasoning opportunities (i.e., Greenfield et al., 2009; Stromholt & Bell, 2017; etc.). Given these findings, it is also essential to understand educators' language to learn and do science with young children. We know educators struggle to bring science into the classroom (i.e., Greenfield et al., 2009; Edwards & Loveridge, 2005; Nayfeld, Brenneman, & Gelman, 2011; etc.) Moreover, professional development interventions need to consider cultural issues and quality aspects across children at home.

The Early Childhood Environment Rating Scale—Third Ed. (ECERS-3; Harms, Clifford & Cryer, 2014) is an observation and rating tool for preschool classrooms serving children ages three to five. The total average ECERS-3 score is an average of the scores on the 35 items under 6 subscales. A rating score between 1 and 7 describes the level of quality. A rating of 1 indicates inadequate quality, a rating of 3 indicates minimal quality, a rating of 5 indicates good quality, and a rating of 7 indicates excellent quality. An overview of each of the 6 subscales on the ECERS-3 is provided in Table 1.

Table 1. ECERS-3 Subscale and Item Descriptions

Subscale	**Description**
Space for Furnishings	Measures the quality of the indoor and outdoor space available to children during the day
Personal Care Routines	Measures the quality of the indoor and outdoor space available to children during the day
Language and Literacy	Measures the quality of the selection of books and other language-related materials in the classroom and the quality of the communication between adults and children to support children’s use of language and reasoning skills
Learning Activities	Measures the quality and quantity of dramatic play, art, music, math, nature/science, sand and water, fine motor skills, and computers
Interactions	Measures the interactions between adults and children and among children

Program Structure	Measures the extent to which children have an appropriate schedule of activities and groupings during the day and are given time to play with materials

The PreK CLASS® (Pianta, La Paro, & Hamre, 2008) is an observational system assessing classroom practices in preschool by measuring educator-child interactions. This tool does not access the presence or absence of materials, the physical environment or safety, or the implementation of a curriculum. Observations consist of four to five 20-minute cycles, with a 10-minute coding period between each cycle. The scale uses a 7-point Likert-type scale, where 1-2 indicates low quality, 3-5 adequate quality, and 6 or 7 means high quality. The *PreK* CLASS® scale is broken down into domains, further broken down into dimensions, measured by behavior indicators, and finally, behavior markers. The three domains in *PreK* CLASS® are Emotional Support (ES), Classroom Organization (CO), and Instructional Support (IS), in Table 2 below.

Table 2. PreK CLASS® Domains and Dimensions Descriptions

Domain	Dimension	Description
Emotional Support (ES)	Positive Climate	Reflects the emotional connection between teachers and children and children and the warmth, respect, and enjoyment communicated by verbal and nonverbal interactions
	Negative Climate	Reflects the overall level of expressed negativity in the classroom. The frequency, quality, and intensity of teacher and peer negativity are key to this dimension
	Teacher Sensitivity	Encompasses the teacher’s awareness of and responsiveness to students’ academic and emotional needs
	Regard for Student Perspective	Captures the degree to which the classroom activities and teacher’s interactions with students emphasize students’ interests, motivations, and points of view and encourage student responsibility and autonomy.
Classroom Organization (CO)	Behavior Management	Encompasses the teacher’s ability to provide clear behavior expectations and use effective methods to prevent and redirect misbehavior
	Productive	Considers how well the teacher manages instructional time and routines and provides activities for students so that they have the opportunity to be involved in learning activities
	Instructional Learning Formats	Focuses on how teachers maximize students’ interest, engagement, and learning abilities from lessons and activities.
Instructional Support (IS)	Concept Development	Measures the teacher’s use of instructional discussions and activities to promote students’ higher-order thinking skills and cognition and the teacher’s focus on understanding rather than on rote instruction
	Quality of Feedback	Assesses the degree to which the teacher provides feedback that expands learning and understanding and encourages continued participation.
	Language Modeling	Captures the effectiveness and amount of teacher’s use of language stimulation and language-facilitation techniques.

Adapted from Pianta, La Paro, & Hamre, 2008

I focus on Item 22 Nature/science in ECERS-3 and IS as defined by the dimensions of *PreK* CLASS®: Concept Development, Quality of Feedback, and Language Modeling. The composite score of these dimensions is the score of the IS domain. First, in Item 22, Nature/science measures the presence/absence of (1) living things, (2) natural objects, (3) factual books/nature-science picture games, (4) tools, and (5) sand or water with toys. It also measures the time children have to reach materials during a three-hour observation. Finally, the item also measures if an educator shows interest in the natural world and co-construct understanding. Next, in CLASS®, to achieve a gain in Instructional Support (IS), educator child engagement, self-reflection, and practice must occur throughout learning. IS focuses on analysis and reasoning (e.g., why and how questions), creating, integrating concepts and previous knowledge, and connecting learning to the real world related to students' lives (Pianta, La Paro, & Hamre, 2008). In short, IS evaluates how educators help children solve problems, reason, think; use feedback to expand and deepen skills and knowledge, and develop more complex language skills. A crosswalk of ECERS-3 Item 22, Nature/science and PreK CLASS Instructional Support (ID) Domain with WA-ELG, HSELOF, and NGSS is provided in Table 1.3 and Table 1.4 below.

ECERS-3 Item 22, Nature/ science	PreK CLASS Instructional Support (IS) Domain	Washington State Early Learning Guidelines (WA-ELG)	Head Start Early Learning Outcome Framework (HSELOF)	Next Generation Science Standards (NGSS) K-2
Materials • Living things • Natural objects • Factual books /nature-science picture games • Tools • Sand or water with toys	No specific mention of science materials.	No specific mention of science materials.	No specific mention of science materials.	No specific mention of science materials.
Accessibility • At least 25 min for a score of 3 during the observation • At least 1 hour for a score of 5, during the observation	No specific mention of the number of times educators should support children's exploration of science.	No specific mention of the amount of time educators should support children's exploration of science.	No specific mention of the amount of time educators should support children's exploration of science.	No specific mention of the amount of time educators should support children's exploration of science.
Educator • Staff use and talk about nature/ science materials with the children • Staff show concern for the environment • Staff initiate activities for measuring, comparing, or sorting using nature/ science materials	**Concept Development** • Analysis and reasoning • Creating • Integrating • Connections to the real world **Quality of Feedback** • Scaffolding • Feedback loops • Prompting thought process • Providing information • Encouragement and affirmation	**Knowledge (cognition)** • Ask a lot of "why" and "what" questions. • Learn by doing hands-on and through the senses. • Learn through play. • Recall several items after they have been put out of sight. • Draw on own past experiences to choose current actions. • Make plans for ways to do something. May or may not follow through. • Think of a different way to do something when confronting a problem, with adult help **Science** • Play with materials of	**Science** Goal P-SCI 1. Child observes and describes observable phenomena (objects, materials, organisms, and events). Goal P-SCI 2. Child engages in scientific talk. Goal P-SCI 3. Child compares and categorizes observable phenomena. Goal P-SCI 4. Child asks a question, gathers information, and makes	**Understanding about the Nature of Science** Category 1: Scientific Investigations Use a Variety of Method Category 2: Scientific Knowledge is Based on Empirical Evidence Category 3: Scientific Knowledge is Open to Revision in Light of New Evidence Category 4: Science Models, Laws, Mechanism, and Theories Explain Natural Phenomena Category 5: Science is a Way of Knowing Category 6: Scientific Knowledge Assumes an Order and Consistency in Natural Systems Category 7: Science is a Human Endeavor Category 8: Science Addresses Questions About the Natural and Materials World **Science and Engineering Practices** Practice 1: Asking Questions and Defining Problems Practice 2: Developing and Using Models Practice 3: Planning and Carrying Out Investigations

	Language Modeling • Frequent conversation • Open-ended questions • Repetition and extension • Self-and parallel talk • Advance language	different textures (such as sand, water, leaves) and conditions (such as wet, dry, warm, cold) with adult encouragement and supervision. • Recognize that different forms of life have different needs. • Recognize that different forms of life have different needs. • Notice and ask questions about what is the same and different between categories of plants and animals. Notice their appearance, behavior, and habitat	predictions. Goal P-SCI 5. Child plans and conducts investigations and experiments. Goal P-SCI 6. Child analyzes results, draws conclusions, and communicates results.	Practice 4: Analyzing and Interpreting Data Practice 5: Using Mathematics and Computational Thinking Practice 6: Constructing Explanations and Designing Solutions Practice 7: Engaging in Argument from Evidence Practice 8: Obtaining, Evaluating, and Communicating Information **Science, Technology, Society, and Environment** 1. Interdependence of Science, Engineering, and Technology 2. Influence of Engineering, Technology, and Science on Society and the Natural World

Table 1.3. ECERS-3 Item 22, Nature/science and PreK CLASS Instructional Support (IS) Crosswalk with WA-ELG, HSELOF, and NGSS

Domain	Dimension	Indicators	Behavioral Markers	Examples
Instructional Support (IS)	Concept Development	Analysis and reasoning	Why and/or how questions Problem-solving Prediction/experimentation Classification/comparison Evaluation	Why do you think ___? What might happen if ___? How do you think ___?
		Creating	Brainstorming Planning Producing	What kinds of materials do we need to build___? What do you plan to do today during ___?
		Integration	Connects concepts Integrates with previous knowledge	We learned about the rain. Today we will learn about snow. How is rain different from snow?
		Connections to the real world	Real-world applications Related to students' lives	When it rains, what are some things we can do?
	Quality of Feedback	Scaffolding	Hints Assistance	The educator provides the student with resources and/or asks additional questions to lead the student to the answer.
		Feedback loops	Back-and-forth exchanges Persistence by teacher Follow-up questions	The educator responds to students and engages with the student in a sustained back-and-forth conversation helping the student understand ideas.
		Prompting thought process	Asks students to explain the thinking Queries responses and actions	The educator using prompting questions so students can explain their thinking and rationale.
		Providing information	Expansion Clarification Specific feedback	The educator provides additional information to expand on students' understanding.
		Encouragement and affirmation	Recognition Reinforcement Student persistence	Wow, that looks hard. Keep going because I think you can ___.
	Language Modeling	Frequent conversations	Back-and-forth exchanges Contingent responding Peer conversations	The educator initiates many conversations about their experiences and understandings
		Open-ended questions	Questions require more than a one-word response Student response	Tell me about ___.
		Repetition and extension	Repeats Extends/elaborates	Repeats or expands on the student's response.
		Self- and parallel talk	Maps own actions with language Maps student actions with language	I am ___ (as the action is happening).
		Advanced language	Variety of words Connected to familiar words and/or ideas	Words that may or may not be familiar

Table 2.4 Instructional Support and Scientific Reasoning

1.3 Evidence Regarding Assessment Quality Standards

In section 1.1, I present research regarding early science education, followed by the need for high-quality early education. Section 1.2 overviews research regarding quality rating and improvement systems (QRIS) as essential to assessing, improving, and communicating a quality rating level to families. I then overview Early Achievers, Washington State's QRIS, and situate assessment quality standards as the drivers for child learning gains and development. Pulling from this research, I connect components of ECERS-3 and PreK CLASS® as essential to evaluate the quality of early scientific reasoning opportunities children experience (i.e., Stromholt & Bell, 2017; Greenfiel et al., 2009; Barajas-López, & Bang, 2018). In section 1.3, to answer the first question, I evaluate evidence regarding ECERS-3 and the PreK CLASS® assessment quality standards studies and how they influence LatinX educators.

1.3.1 Evidence Regarding ECERS-3

The Early Childhood Environment Rating Scale – Third Edition (ECERS-3; Early, Sideris, Neitzel, LaForett, & Nehler, 2018) is the updated version of an observational tool for assessing the quality in preschool classrooms. The Early Childhood Environment Rating Scale-Revised (ECERS-R; Harms, Clifford, & Cryer, 2005) is the predecessor of ECERS-3, a significant component of quality measurement in nearly all of the Quality Rating and Improvement Systems (QRIS) across the United States (Quality Compendium, 2021). An ECERS-3 observation was conducted in 944 classrooms in three states: Georgia, Pennsylvania, and Washington. Zaslow, Burchinal, Tarullo, and Martinez-Beck (2016) argue the field's knowledge of high-quality instruction is improving and involves "engaging activities, small and large group instruction, and sequenced presentation of instructional materials that allow for deep learning…”. To summarize, no single tool exists for measuring all aspects of quality; however, combining interaction-specific and domain-specific quality measures could be necessary.

1.3.2 Evidence Regarding PreK CLASS®

The CLASS is a widely used educator-child conversation assessment. The research leading to the CLASS® tool's current version began in 1991 as a part of the National Institute of Child Health Human Development (NICHD) Study of Early Child Care and Youth Development (SECYD) (NICHD, 2001). The study examined the influence of early environments and classroom processes on various family backgrounds' development. Fifty-six percent of families were living-above-poverty in the total study population, 23 percent were living-near-poverty, and 21 percent were living-in-poverty. The study shows children receiving higher quality care show slightly more positive outcomes than those in lower-quality care. In addition, family characteristics predict children's cognitive/language and social development; parents' education, family income, and two-parent family compared to a single-parent family; mothers' psychological adjustment and sensitivity; and the home environment's social and cognitive quality (NICHD, 2001).

CLASS® is a well-researched and validated measure of classroom quality. Most early childhood studies on CLASS® have been conducted in diverse settings serving at-risk populations of children. Many validation studies among diverse Pre-K populations, Dual-Language-Learners, Internationally, and tribal communities. Considerations for observers "knowing tribes" and to be "aware of cultural variations in behavior, understanding when it is appropriate to code, and knowing the languages in the classrooms" (Barnes-Najor, Thompson, Cameron, Smith, Calac Verdugo, Brown, & Sarche, 2021). Intentional and meaningful research is needed to enhance cultural competence in their work. The National Overview of Grantee

CLASS® Scores has data for 2016, 2017, 2018, 2019, and 2020 (ECLKC; Retrieved May 14, 2021). The data is not discussed by educator race. Therefore, we do not know how educators from LatinX backgrounds score in these measures (Downer, López, Grimm, Hamagami, Pianta, & Howes, 2012). Perhaps LatinX educators are made to feel like their funds of knowledge are not valuable. In reality, they are experts because of their lived experiences (Bang 2016; Rogoff, 2003; Barajas-López & Bang, 2018; Espinosa, 2010; González, Moll, & Amanti, 2005; Yosso, 2005).

1.3.3 Evidence Regarding How LatinX Educators Fare in ECERS-3 and PreK CLASS®

In 2018-2019, Early Achievers, Washington State's QRIS policy, used ECERS-3 and PreK CLASS® to rate and monitor classroom quality. Most recently, Hestenes, Rucker, Wang, Mims, Hestener, and Cassidy (2019) evaluate ECERS-3, the most recent iteration of ERS tools. The authors find that the "six lowest scoring items on the ECERS-3 were related to requirements for educator-child interactions that must be observed related to the use of specific types of learning materials or practices." Specifically, to Item 22 Nature/science, out of 105 observed classrooms, the mean was 3.12 with a standard deviation of 1.19. Similarly, Early, Sideris, Neitzel, LaForett, and Nehler (2018) show ECERS-3 Learning Opportunities and Teacher Interactions were significant to predicting Instructional Support ($p<.001$). The authors show the ECERS-3 subscale is most strongly associated with PreK CLASS® was Teacher Interactions, which provides evidence for convergent validity since PreK-CLASS® is intended to measure teacher-child interactions (Early, Sideris, Neitzel, LaForett, & Nehler; 2008). The authors show that Item 22 Nature/science, out of 1063 observed classrooms, had a mean of 2.54 and a standard deviation of 1.17. Another study furthers the research community's understanding of the cultural issues in the use of ECERS-3 (Garvis, Sheridan, Williams & Mellgren, 2017). The authors suggest "adaptation needs to be with care, considering cultural issues and quality aspects based on research and proven experience in preschool." While many ECERS-3 indicators are transferable, reflections about the cultural and contextual differences are discussed in three themes: (1) physical environment and room organization, (2) interactions and supervision, (3) learning activities and language development. More scientific concepts are demanded within Item 22 Nature/science; "the curriculum makes strong connections with nature and the environment, with children often engaged in learning activities with the natural environment." Differences surrounding curriculum, preschool design, and pedagogy around interactions and safety issues probe the research community to consider cultural adaptations across communities.

As for PreK CLASS®, out of 118 observed classrooms, Instructional Support had a mean of 2.26 with a standard deviation of 0.69 (Early, Sideris, Neitzel, LaForett, & Nehler, 2018). These findings are similar to other studies (Hindman & Wasik, 2013; Burchinal, Field, Lopez, Howes, & Pianta, 2021; Moiduddin, Aikens, Tarullo, West, & Xue; 2012), where IS mean scores are low. While the studies reported the demographics of children, it is essential to note that educators' race/ethnicity was not reported. In particular to this study, we need to know how LatinX educator-led classrooms fare quality assessment standards to explore if cultural adaptation is necessary and inform quality improvement efforts to enhance child well-being. In quality, having educator demographics matters to gain perspective on generalizable findings to contexts; such findings inform continuous quality improvement. Further, the studies did not intentionally understand how educator or child race/ethnicity affects quality standards. In other words, I have not found research that specifically centers on LatinX educators and how they fare in ECERS-3 or PreK CLASS®. Yet, research shows "children with more instruction in Spanish promotes reading and math skill development among these very vulnerable children who are struggling to learn English, especially when they attend high-quality programs" (Burchinal, Field, Lopez, Howes, & Pianta, 2012). The need for high-quality bilingual educators who feel comfortable and confident in early science learning is critical to helping young children develop emerging scientific reasoning. It is essential to note that Burchinal, Field, Lopez, Howes, and Pianta's (2012) study focused on Prek CLASS® and dual language learners, though no educator demographics were reported. Furthermore, this study shows the lowest PreK CLASS Instructional Support score mean of 1.97, compared to other studies (i.e., Moiduddin, Aikens, Tarullo, West, & Xue, 2012; Early, Sideris, Neitzel, LaForett, & Nehler, 2018). Refer to Appendix C for a detailed description.

Pulling from this research, there is a pressing need for research efforts to explore the nuances of how educators fare in quality assessments by educator race/ethnicity. This study seeks to investigate how LatinX educators participating in Early Achievers, Washington State's QRIS policy, fare on assessments related to enhancing children's development of emerging scientific reasoning skills. While these assessments are widely used and capture a version of quality, the second question seeks to disrupt the invisibility of LatinX educator-led classrooms and voice the cultural wealth and knowledge of LatinX educators in ECE classrooms. To do this, I investigate how LatinX educators understand and discuss their science teaching.

Chapter 2: Conceptual Framework

To overview, I discussed early science learning and its importance. Next, I overviewed Early Achievers, Washington State's QRIS, and situated assessment quality standards as the drivers for science child learning gains and development. I discussed the importance of science education in preschool classrooms, claiming instructional support, as measured by CLASS®, evaluates educator-child conversation facilitating emergent scientific reasoning. Further, ECERS-3, Item 22 Nature/science measures the presence/absence of materials and educator facilitated nature/science discussions. Now I transition into a cultural-historical activity theory (CHAT) framework - a model (Haraway, 2016) that situates nondominant educators' beliefs and value systems for quality improvement in terms of science education.

2.1 The Unit of Analysis

The necessary catalyst for progress is the power to think-with, live-with, and be-with social (human), natural, and physical worlds (Haraway, 2016). "A model is a work object… A model is worked, and it does work… It matters what ideas we use to think of other ideas (with). It matters what we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds; what worlds make stories (Haraway, 2016). "Activities within a model are not isolated units but are rather more like nodes in crossing hierarchies and networks; other activities influence them and other changes in the environment" (Engeström, 1999).

Problematizing subjects, tools, rules, and divisions of labor is an epicenter where the ECE research community needs to invest time and thinking. Cultural History Activity Theory (CHAT) situates learning as a process of activity: a purposeful interaction of the subject and components influencing the outcome (Leont'ev, 1974). Models serve to do work and work with the object controlling its projection to the outcome (Edwards, 2005; Leont'ev, 1974). This study's primary objective is to disrupt the invisibility and uncover the cultural wealth and knowledge of LatinX educators in ECE classrooms.

An essential element of activity systems is exploring the tension and contradiction. Activity theory uses the term contradiction to indicate a misfit within elements between different activities or between different developmental phases of a single activity. A contradiction is a source of development; activities are virtually always in the process of working through contradictions (Kuutti,1996). A mycelial network characterizes the individual mind, from cultures, morals, ethics to everyday actions. The sources of contradictions identify the needs and the resolution/s making an outcome. In this study, the objective is to use a CHAT model for exploring the activity of Early Achievers, Washington State’s QRIS, in relation to (1) how LatinX ECE educators' fare in assessment quality standards related to science education, and (2) how do LatinX ECE educators understand and discuss science teaching.

Next, I map out the activity triangle for LatinX ECE educators. See Figure 4. The **Subject(s)** are early childhood care educators currently teaching in the state of Washington. Every educator is an individual learner and part of collective learning from a CHAT model, mediated by multiple tools**. Tools** can include professional development opportunities and resources. Tools are also other members involved in education – community practice, family engagement and partnership, and other human resources for accessing information, gaining feedback, creating knowledge, clarifying understanding, and pressing others on conceptual ideas. Another tool is what an individual(s) brings to the activity of focus, for example, their use of language(s). Next, the **Object** is an educator's science education perspective, followed by the extent to which predictors such as educational and lived experience, professional development and training, and Early Achievers' participation influence their knowledge. The **Outcome** is the co-construction of scientific education from nondominant communities. Next, the **Community** determines the **Rules. Rules** involve expectations, day-to-day activities of children in care, and social practices. Educator and child sense-making practices can also be emergent and evolve during the day as educators regulate. In contrast, the **Community** involves families, students, and educators, but educators' competence directs science education in the classroom. Lastly, the **Division of Labor** requires policy stakeholders from sovereign nations, federal, state, city, and others.

Exploring the intersectionality of power disruptions throughout units and how a model contributes to knowledge must be addressed to make progress—figure 4 models the projected contradictions and power ruptures within and across varying concepts. The model is a vehicle to work with and highlight tensions from and to nodes between (1) **subjects** to the **community**: problematizing *what is science* and *when is science* from multiple standpoints, and (2) **subjects** to the **tools**: adaptations of quality assessment standards need to be with care, considering cultural issues as well as quality aspects from various perspective, in particular to this study ECE LatinX educators. These contradictions are drivers of future research efforts and implications for policy and practice change in QRIS.

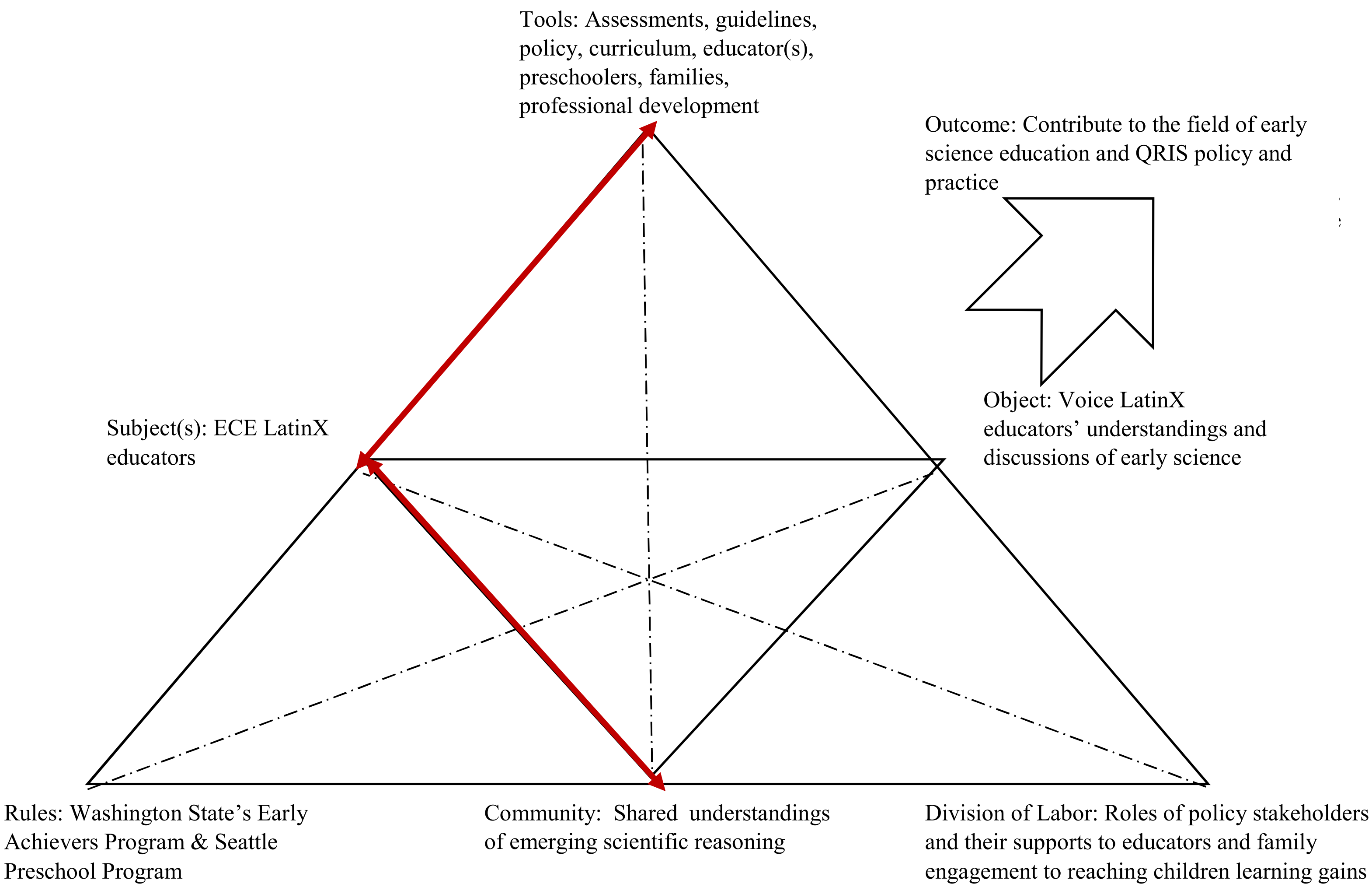


Figure 4. Stakeholder groups' definitions of early care and education

Chapter 3: Sequential Explanatory Mixed Method Design

This study explores LatinX ECE educators' perspectives towards teaching science. "Knowledge is involved in making things matter" (Puig de la Bellacasa, 2017); towards this objective, this study values nondominant communities' epistemic sense-making practices, multiple right ways of being as scientific inquiry. By problematizing "what is science" and "when is science," we are reimagining possible futures of science education for children to succeed. In the following sections, I first overview sequential explanatory mixed methods design, followed by secondary data descriptive analysis. Next, I use descriptive analysis for LatinX educator survey and I thematically code my thinking group prompting questions following a deductive approach.

3.1 Research Design: Sequential Explanatory Mixed-Methods

I use a sequential explanatory mixed-methods study design consisting of two phases: quantitative followed by qualitative (Creswell, 1995; Creswell et al. 2003). In mixed-methods design the timing of the quantitative and qualitative components is essential. The goals of the study guide the phases of data collection; sequential or concurrent. When sequential, the first data collection phase helps inform the second phase, or the second phase aids in the interpretation of the data collected in the first phase. Whereas, concurrent data collection reduces the time required to collect data. In this study, I use a sequential explanatory strategy, where quantitative data are collected and analyzed first and the results inform the subsequent qualitative phase. The qualitative phase will explore results from the initial quantitative phase. The goal of mixed-methods is to draw on the unique strength of each phase to provide a more complete understanding than would be possible with only one approach.

Since the goal of the current study is to explore how LatinX educator led classrooms fare in ECERS-3 Item 22 Nature/science and PreK CLASS Instructional Support (IS), followed by how LatinX educator led classrooms understandings and discussions of early science, the sequential explanatory design matches the needs of the research approach. The quantitative phase provides general patterns and width and the qualitative data reflects on the experiences and depth (Newby, 2014). The findings from the qualitative data help contextualize and enrich the findings (Bryman, 2004, Manson 2006), increase validity when interpreting data (Orgard, 2005), and generate new knowledge (Stange, 2006). The interpretation of the findings are informed by the quantitative data, qualitative data, and the literature review. Moreover, CHAT is a useful tool to explore the intersectionality of quality assessment standards and LatinX educator's understandings and discussions of early science. See Figure 5.

First, I explore a secondary descriptive analysis of the 2018-2019 Seattle Preschool Program data to evaluate what science teaching looks like in LatinX educator-led-classrooms. Next, I use a qualitative approach to describe LatinX educators' understandings and discussions of early science. This study seeks to disrupt the invisibility of nondominant communities' cultural wealth (Stromholt & Bell, 2017; Yosso, 2005; Medin & Bang, 2005) by avoiding a comparative history. Instead, I situate on LatinX educator-led classroom perspectives alone. Not doing so would result in discussing findings and their implications across dominant and nondominant communities.

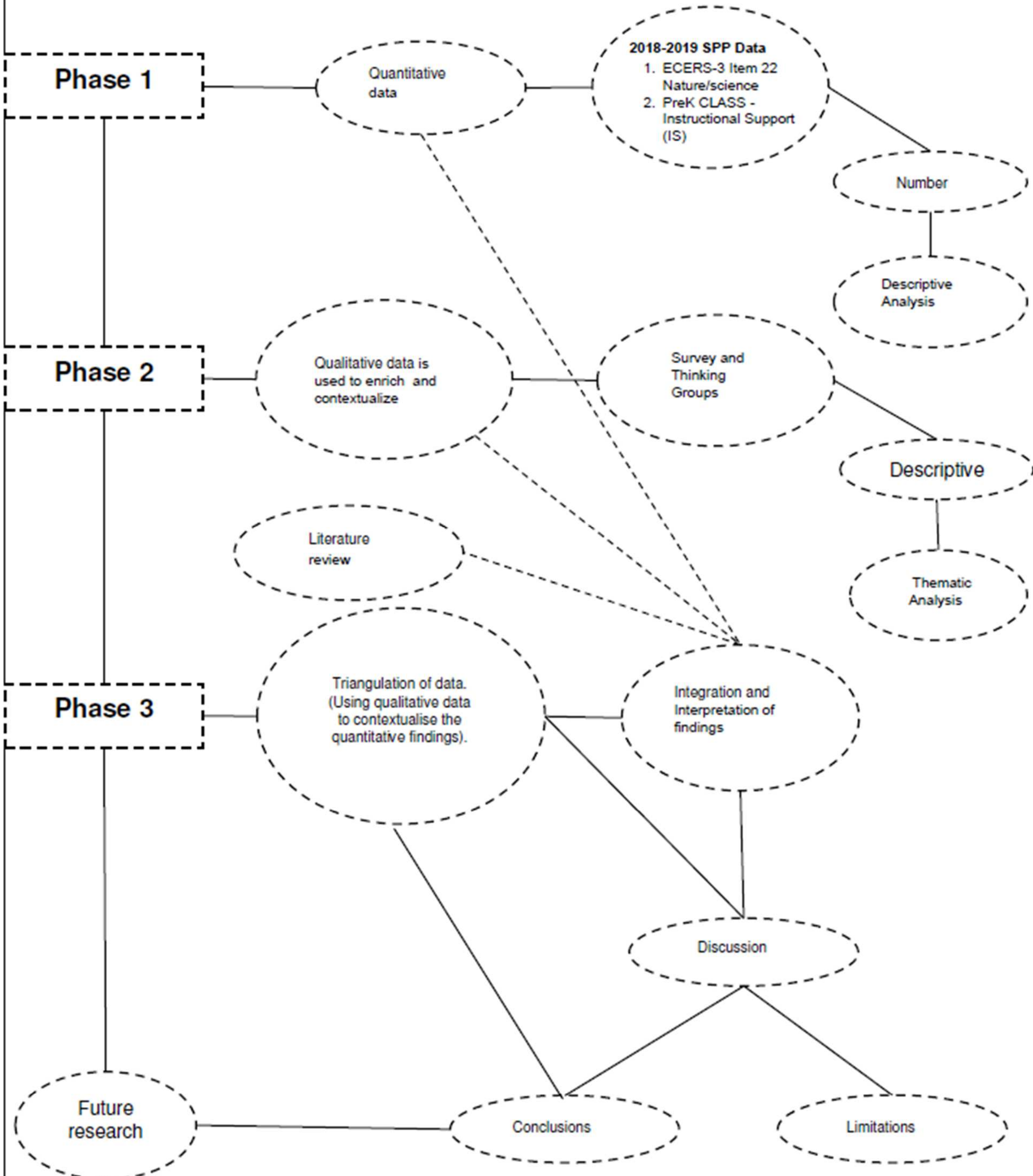


Figure 5

Overview of research (Triangulation: explanatory/ sequential process)

3.1.1 Quantitative

I use descriptive analysis of the 2018-2019 Seattle Preschool Program to explore the broad question: **What do ECERS-3 and PreK CLASS quality measures indicate about science teaching in LatinX educator led classrooms?** I focus on curriculum, class size, agencies, lead educator qualifications, lead educator primary language, lead educator gender, lead educator primary language, program participation years in SPP, mean CLASS instructional support scores, and ECERS-3 Item 22 Nature/science scores. I hypothesize that LatinX educators led classrooms to fare lower in ECER-3 Item 22 Nature/science and Pre-K CLASS® Instructional Support. Further, to help explain findings, I will conduct a survey and thinking group prompting questions (adapted from research in Table 1.4). Finally, I will analyze the survey with descriptive statistics and thematically code the thinking group understandings and discussions of early science. Together both of these components disrupt the invisibility of LatinX educators' understandings and discussions when teaching science.

3.1.2 Qualitative

Next, I use descriptive statistics to identify trends in the survey, followed by thematically coding my thinking group data using a deductive approach. It is important to note that the survey and the thinking group prompting questions are adopted from the literature review, refer to Table 1.4. The descriptive statistics and deductive approach answer the broad question, **how do LatinX educators understand and discuss their early science teaching?**

I use multiple methods or data sources to triangulate findings (Polit & Beck, 2012). I conducted a focus group with LatinX educators in ECE and a questionnaire to fill this research gap. Brown (1999) indicates thinking (focus) groups allow for "dynamic and interactive exchanges among participants [to produce] multiple stories and diverse experiences." In short, data triangulation results in a broader understanding of the state of quality in LatinX led classrooms. Furthermore, the investigation explores LatinX educators' understanding and discussions of early science. Thus, I can discuss breadth and depth of understanding and corroboration regarding LatinX educators in ECE by carrying out a sequential explanatory design.

I used purposeful sampling (Merriam & Tisdell, 2016). This study has several different purposeful sampling strategies, combining homogeneity, snowball, and critical case sampling. First, homogeneity describes participants' experiences in-depth to reduce variation. Second, the snowball effect allows participants to bring people they know they believe they meet the criteria. In comparison, critical case permits logical generalization and maximum application of information. In other words, if it is true in this one case, it is likely to be true in all other cases with participant input and guidance. Finally, the combination of these strategies increases the number of participants in the study.

The sampling frame is current LatinX educators in ECE. Through convenience sampling methods, I bridged connections with community advocates. However, due to the limitation of IRB, I was unable to collaborate with DCYF educators. The aim was to have a listening group for LatinX educators. Participants' understanding and discussion of early sciencan effectively identify 'what,' 'why,' and 'when' professional development.

Stake (1995) states, "issues are not simple and clean, but intricately wired to political, social, and especially personal contexts. All these meanings are important in studying cases." An affordance of case study research uses multiple data sources, a strategy that also enhances data credibility (Patton, 1990; Yin, 2003). The data sources collected include notes, tabular materials, narratives, and transcribed audio files in this study. The multiple source data is converged in the analysis process rather than evaluating them individually. Thus, each data source contributes to the understanding of the whole phenomenon. This convergence strengthens the findings as the various strands of data are triangulated to understand the case better. Data source triangulation is a way of validating data (Stake, 1995; Yin, 2014).

In my analysis method, I link the findings and discussions to the propositions (or issues) to explore alternative explanations for a phenomenon (Yin, 2003). "Issues are not simple and clean, but intricately wired to political, social, and especially personal contexts. All this meaning is important in studying cases" (Stake, 1995). The findings' confidence increases as propositions are addressed and accepted or rejected by connecting to a literature review. It is vital to converge data to understand the phenomenon or the contribution of factors influencing the case. Exploring a concept or phenomenon involves telling a story of meaning for several individuals of their lived experiences (Creswell (2007). This way, I can compare case study findings with a predicted one before data collection (or several alternative predictions). If the empirical and predicted patterns appear similar, the results can help strengthen internal validity.

I will also double code and member checking to improve the validity and reliability of data "making sense." By following this process, findings are co-constructed between the "knower" and "known" (Merriam, 1998). Data will be double-coded with the facilitator of the listening group or a member of the community. The aim is to focus on why phenomena might be happening for whom. I explicitly center on participants' voices (Mitra & McCormick, 2017) – as there is no such thing as an average educator, parent, or child. Member checking highlights individual and community leaders' voices and leads to consensually constructed, coordinated actions.

According to Braun & Clarke (2006), "a theme captures something important about the data concerning the research question and represents some level of the patterned responses or meaning within the data set." This study will refer to propositions or issues. The propositions or issues will guide the selection of themes. An inductive approach or "bottom-up" (Glesne, 2016) suggests theme selection. An inductive approach means the themes (or issues) link to the data themselves (Patton, 1990). This analysis can develop a concept explaining ECE Latinx educators' primary concerns, followed by how they are resolved or processed. In short, another way of thinking of an inductive approach is as a discovery of emerging patterns in the data to situate participants' lived experiences is essential. Next, there are two levels to identify themes: semantic or latent (Boyatzis, 1998). The semantic approach identifies the themes from a surface meaning of the data. The analysis does not go beyond what a participant says or writes. A latent approach identifies or examines the underlying ideas, assumptions, and conceptualizations informing the data's content. I will use a latent strategy in this study, which aligns with the inductive method (bottom-up).

3.1.2 Survey and Thinking Group Prompting Questions

The survey and thinking group data were thematically coded broadly around the sub-questions related to the research questions. The sub-questions identified educators use of teaching strategies they employed when supporting children’s scientific learning; for example, materials, instructional supports, curriculum, and ECE guidelines (Tu, 2006; Tu & Hsiao, 2008; Greenfield et al., 2009; Maier, Greenfield & Bulotsky-Shearer, 2013; Pendergast et al., 2017; Fleer & Gomes; 2014). Moreover, sub-questions were organized to explore how educators defined science (Edwards & Loveridge, 2011; Merino et al., 2013; Greenfield et al., 2009), what they saw as informing their views of science (Greenfield et al., 2009; Maier, Greenfield &

Bulotsky-Shearer, 2013; Pendergast et al., 2017; Nayfeld et al., 2011), including their concerns about teaching science (Greenfield et al., 2009; Maier, Greenfield & Bulotsky-Shearer, 2013; Pendergast et al., 2017), experiences with coaching (Maier, Greenfield & Bulotsky-Shearer, 2013; Pendergast et al., 2017; Nayfeld et al., 2011), and what they saw as enabling or hindering them (Greenfield et al., 2009; Maier, Greenfield & Bulotsky-Shearer, 2013; Pendergast et al., 2017). Another set of data drawn from the surveys concerned their background information and helped identify similarities with, and differences from, the participant's previous lived experiences (i.e., sources from Table 1.4). The survey and thinking group questions were adapted from the literature review in Table 1.4.

I will evaluate data for "Teaching and Learning" and "Knowledge, Values, and Beliefs through thematic analysis." *Teaching and Learning* measures educators' perspectives on what, where, and how to learn and teach science. *Knowledge, Values, and Beliefs* assess educators' views on their epistemic science practices. I will organize these codes to create three categories: educator comfort, educator challenges, and child benefit. Refer to Table 1.4 for literature review.

3.2 Secondary Data Analysis of the 2018-2019 Seattle Preschool Program

On November 4, 2014, a four-year property tax levy was approved to provide accessible, high-quality preschool services for Seattle children, known as Seattle Preschool Program (SPP). The National Institute of Early Education Research (NIEER) and Cultivate Learning at the University of Washington led the impact evaluation for year one (2015-2016), year two (2016-2017), year three (2017-2018), and year four (2018-2019), focusing on classroom quality and children's learning. In addition, I conducted a secondary descriptive analysis to discuss the science teaching and learning in LatinX led classrooms of SPP academic year four.

Participants

The 2018-2019 Seattle Preschool Program data set has 74 center classrooms and 11 family childcare providers. The total study population is 85 educators and 1352 children. The 2018-2019 SPP can participate in educators' first, second, third, or fourth year. Classroom and educator characteristics are reported in Table 5. Three educators do not meet SPP qualifications, at least a bachelor's degree in ECE.

Table 5. 2018-2019 SPP LatinX led Classroom characteristics, N=9.

Classroom Characteristics		SPP Classroom Frequency of Mean (SD)
Curriculum	Creative HighScope	4 5
Class Size Number of Agencies		17.22 (4.52) 8
Lead Educator Gender	Female Male	8 1
Lead Educator Primary Language	Spanish English	4 5

Measure: The Early Childhood Environment Rating Scale-Third Edition (ECERS-3; Harms, Clifford, & Cryer, 2015) Item 22 Nature/science

The ECERS-3 contains 35 items within six subscales (Space and Furnishings, Personal Care Routines, Language and Literacy, Learning Activities, Interactions, and Program Structure). Each item is rated from 1 (inadequate), 3 (minimal), 5 (good), to 7 (excellent) based on multiple indicators under the 1, 3, 5, 7 ratings. The ratings are completed based on three-hour observations in preschool-aged classrooms (2.5-5 years of age). Within the Learning Activities subscale, item 22, Nature/science measures the presence/absence of nature/science materials, including a sand/water area with toys. These materials are accessible, followed by educators' use and talk about Nature/science materials. See Table 6 below.

Table 6. Item 22 Nature/science indicator score 1=met indicator, 0= did not meet the indicator

ECERS-3 Item 22 Nature/science _Indicator Level
1.1 No nature/science materials accessible
1.2 Staff do not talk about nature/science with the children during the observation (Ex: mention weather, seasons; read a factual book on animals; mention water temperature).

1.3 Staff show a lack of interest or dislike for the natural world (Ex: show fear of a large spider instead of cautious respect; ignore natural occurrences).
3.1 At least 5 developmentally appropriate nature/science materials from at least 2 categories are accessible for at least 25 minutes during the observation.
3.2 Staff talk about nature/science with the children during the observation (Ex: do weather chart; ask names of animals in pictures; talk about healthful food as a snack).
3.3 Sand or water, with appropriate toys, is accessible for at least 25 minutes during the observation.
5.1 At least 15 nature/science materials, some from each of the 5 listed categories, are accessible in a clearly defined nature science interest center for at least 1 hour during the observation.
5. 2 Staff use and talk about nature/science materials with the children.
5.3 Staff model concern for the environment (Ex: remind children to turn off the water or turn off light to save resources; recycle; discuss how insects can be helpful).
7.1 Staff initiate activities for measuring, comparing, or sorting using nature/science materials (Ex: show children how to sort seashells by color, shape, or size; arrange pinecones from biggest to smallest; chart rainfall for a month to discuss dry and wet times; predict weights of various natural objects).
7.2 One or more pets/plants present that children can easily observe, help care for, and that are talked about with the children (Ex: classroom fish tank, hamster, gerbil; birds that are seen visiting filled bird feeder).

Measure: CLASS® (*CLASS®; Pianta, La Paro, & Hamre, 2008) Instructional Support*

The PreK CLASS is an observational system of educator-child interactions in preschool and kindergarten classrooms. Observations consist of four 20-minute cycles, with approximately 10-min coding periods between each cycle. There are three domains: Emotional Support (ES), Classroom Organization (CO), and Instructional Support (IS). Within each domain, there are dimensions and behavioral indicators. Each dimension is rated from Low (1, 2), Mid (2, 3, 4), and High (6, 7). The domain averages are calculated once each dimension receives a score across the four cycles. See Table 7 below.

Table 7. PreK CLASS® Instruction Support Domains and Dimensions Descriptions

Domain	Dimension	Description
Instructional Support (IS)	Concept Development	Measures the teacher's use of instructional discussions and activities to promote students' higher-order thinking skills and cognition and the teacher's focus on understanding rather than on rote instruction
	Quality of Feedback	Assesses the degree to which the teacher provides feedback that expands learning and understanding and encourages continued participation.
	Language Modeling	Captures the effectiveness and amount of teacher's use of language stimulation and language-facilitation techniques.

3.3 Survey and Thinking Group Data

As a member of the LatinX community, I understand the history and complexity of our identity. It is essential to understand, in 1848, the border crossed and divided the Mexican population; this is the Treaty of Guadalupe Hidalgo. The Mexican Cession consists of present-day U.S. states of California, Nevada, Utah, most of Arizona, the western half of New Mexico, the west quarter of Colorado, and Wyoming's southwest corner. The state of Texas was acquired shortly after by the U.S. In 1942, the Bracero program brought Mexican farmworkers, followed by their families, into the U.S. *Why does this matter?* It is essential to understand LatinX communities have been and continue to be part of U.S. land. Each of us has a shared history with differences in our ancestors, which form our identity.

3.3.1 Participants

Table 8 below shows descriptive statistics of 2018-2019 SPP LatinX educator led classroom.

Table 8. 2018-2019 SPP LatinX led Classroom characteristics, N=7.

Classroom Characteristics		SPP Classroom Frequency of Mean
Curriculum	Creative	5
	HighScope	2
Lead Educator Gender	Female	8
	Male	1
Lead Educator Primary Language	Spanish	4
	English/Spanish	3

3.3.2 Survey

I sent a questionnaire to educators before we gathered for our thinking group (focus group). The questionnaire was adapted from various sources (i.e., sources in Table 4). The questionnaire asked educator and program demographics, age taught, program specifics, coaching, and more. Refer to Appendix A.

3.3.3 Thinking Groups

On Saturday, February 29th, we gathered for 6 hours for LatinX educators to share their science teaching and lived experiences. The group was semi-structured, where I asked open-ended questions to prompt discussion on topics that emerged. The open-ended questions were adapted from various sources (i.e., sources in Table 4). Refer to Appendix A.

Chapter 4: Findings en *"Discusión"*

As a first-generation LatinX American farmworker, I make sense of the world from multiple vantage points. My viewpoints typically do not co-exist with each other, and these in-between spaces guide me in rethinking my understanding and knowledge of my developing worldview. I am aware of my insider and outsider positionality when making connections with community members and telling stories. Because of our COVID-19 trying times, I could not have more than one thinking group. Therefore, this study will situate on the LatinX voices from a thinking group. I am a member of the LatinX community, an early childcare education learner, educator, and advocate for quality education rooted in equity. Because of my background, I can relate and connect with LatinX educators' understandings and discussions of early science. A resonating level of trust and understanding among us allows me to listen, narrate, and represent their voices, experiences, and teachings.

4.1 LatinX Educators Led Classrooms and Science Reasoning

To overview, after reviewing evidence regarding quality assessment standards – studies indicate adaptations need to be done with care, considering cultural issues and differences in quality aspects (i.e., Hestenes et al., 2019, Early et al., 2018, Hindman & Wasik, 2013). For example, Garvis and colleagues (2017) discuss three main themes emerging from group discussions: (1) physical environment and room organization, (2) interactions and supervision, and (3) learning activities and language development. Specifically, 153 Swedish preschool classrooms scored low on Nature/science even though the curriculum makes strong connections with nature and the environment. Pulling from this research, this study's second question aims to fill a research gap of how LatinX educators fare in quality assessment standards. Unfortunately, findings indicate uneven quality instruction among LatinX led classrooms. The problem of uneven exposure has been reported in other studies examining high-quality instruction in pre-K (Pianta, Belsky, Houts, Morrison, & NICHD ECCRN, 2006; Goodvin & Rashid, 2020). The following sections will discuss possible reasons why this might be. But, first, I overview the data sample.

In the 2018-209 Seattle Preschool Program (SPP), nine Latinx educators led preschool classrooms. The Early Childhood Environmental Rating Scale—Third Edition (ECERS-3) average scores are 4.20 (0.51) for LatinX led classrooms. Therefore, I first present descriptive statistics of LatinX educators-led classrooms. I then move to evaluate ECERS-3 Item 22 Nature/science and the CLASS® Instructional Support scores from the 2018-2019 Seattle Preschool Program. Next, I broker (Ishimaru, Salvador, Lott, Williams & Tran, 2016) the voice of the LatinX educators in Seattle, Washington.

4.1.1 What are the characteristics of LatinX educators?

Table 9 shows the characteristics of LatinX educators-led classrooms participating in EA in the 2018-2019 SPP. When investigating quality, past studies report educators' choice of curriculum, gender, primary language, level of education, years in a program, and ECERS-3 and Prek CLASS® scores (i.e., Hindman & Wasik, 2013; Burchinal, Field, Lopez, Howes, & Pianta, 2012; Garvis, Sheridan, Williams & Mellgren, 2017). It is important to note that while these characteristics are reported, analysis on such associations was not carried out, except for education level. Evidence regarding the associations of education level and classroom quality indicates that higher educator qualifications are linked to higher quality (Burchinal, Cryer, Clifford & Howes, 2002; NICHD ECCRN, 2002, Barnett, 2003; Hestenes et al., 2019). Evidence also shows that professional development specific to science supports educator quality of instruction (Wilkins, 2008; Palmer, 2011; Maier, Greenfield, Bulotsky-Shearer, 2013; Pendergast et al., 2017). We also know that SPP educators receive continuous quality improvement support, professional development, and training to enhance the quality of early childhood programming (Early et al., 2017). However, it is important to note that 2018-2019 SPP data does not monitor program and educator participation time. In other words, we do not know how long educators have received continuous quality improvement support. The following section will discuss quality assessment standard scores.

Table 9. 2018-2019 SPP LatinX led Classroom characteristics by participant, N=9.

Participant Number	1	2	3	4	5	6	7	8	9
Curriculum	HS	HS	C	HS	HS	HS	C	C	C
Gender	F	F	F	F	F	F	F	F	M
Primary Language	Span	Eng	Span	Eng	Eng	Eng	Span	Eng	Span
Education Level	A	B	B	B	B	M	B	B	B
Years in SPP	2	3	3	4	3	1	2	1	2
IS Mean	1.50	2.08	2.17	2.25	2.25	2.42	3.17	3.33	3.42
Item 22 Nature/science Score	2.00	2.00	4.00	1.00	3.00	7.00	4.00	3.00	3.00

Note: HighScope (HS), Creative (C), Female (F), Male (M), Spanish (Span), English (Eng), Associates (A), Bachelors (B), Masters (M)

4.1.2 ECERS-3 Item 22 Nature/science

As aforementioned, the ECERS-3 Item 22 Nature/science (Harms, Clifford, & Cryer, 2015) measures the presence/absence of (1) living things, (2) natural objects, (3) factual books/nature-science picture games, (4) tools, and (5) sand or water with toys. Table 10 contains the classroom proportions that describe how LatinX educators fare on Item 22 Nature/science. More than 80% of LatinX led classrooms were observed to be meeting each of the following indicators: 1) having nature/science materials accessible, 2) staff talking about nature/science with children during the observation, 3) staff show interest in the natural world, 4) at least 5 developmentally appropriate nature/science materials from two materials are accessible for 25 minutes during the observation, 5) staff talk about nature/science with children during the observation. However, less than ¾ of LatinX led classrooms met the various other indicators of nature/science. For example, indicators 5.1 and 7.1 require more nature/science materials to be accessible for 1 hour, and staff intentionally facilitating emergent scientific reasoning skills were met less than ¼.

Table 10. Proportion of classrooms meeting Nature/science indicators

Lead Educator ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
ECERS-3 Item 22 Nature/science Item Score (n=9, M = 3.22, SD=1.72)	2	2	4	1	3	7	4	3	3
ECERS-3 Item 22 Nature/science at Indicator Level									
ECERS-3 Indicator Description	**Proportion meeting indicator, mean (SD)**								
1.1 No nature/science materials accessible	1.00 (0.00)								
1.2 Staff do not talk about nature/science with the children during the observation (Ex: mention weather, seasons; read a factual book on animals; mention water temperature).	0.88 (0.35)								
1.3 Staff show a lack of interest or dislike for the natural world (Ex: show fear of a large spider instead of cautious respect; ignore natural occurrences).	1.00 (0.00)								
3.1 At least 5 developmentally appropriate nature/science materials from at least 2 categories are accessible for at least 25 minutes during the observation.	1.00 (0.00)								
3.2 Staff talk about nature/science with the children during the observation (Ex: do weather chart; ask names of animals in pictures; talk about healthful food as a snack).	0.88 (0.35)								
3.3 Sand or water, with appropriate toys, is accessible for at least 25 minutes during the observation.	0.50 (0.53)								
5.1 At least 15 nature/science materials, some from each of the 5 listed categories, are accessible in a clearly defined nature science interest center for at least 1 hour during the observation.	0.25 (0.46)								
5.2 Staff use and talk about nature/science materials with the children.	0.50 (0.53)								
5.3 Staff model concern for the environment (Ex: remind children to turn off the water or turn off light to save resources; recycle; discuss how insects can be helpful).	0.63 (0.52)								
7.1 Staff initiate activities for measuring, comparing, or sorting using nature/science materials (Ex: show children how to sort seashells by color, shape, or size; arrange pinecones from biggest to smallest; chart rainfall for a month to discuss dry and wet times; predict weights of various natural objects).	0.13 (0.35)								
7.2 One or more pets/plants present that child can easily observe, help care for, and that are talked about with the children (Ex: classroom fish tank, hamster, gerbil; birds that are seen visiting filled bird feeder).	0.38 (0.52)								

First, for the most part, LatinX educators led classrooms with at least an adequate quality score (3 or above) in ECERS-3 Item 22 Nature/science had a higher IS mean score. Interestingly, LatinX educator-led classrooms' primary language did not influence quality standard scores in this small sample. Moreover, LatinX educators led classrooms (3 out of 5) following an HS curriculum did not meet an adequate score (score of 3). Recent research indicates that educators' education levels showed significant differences in ECERS-3 scores (Hestenes et al., 2019). Hestenes and colleagues (2019) show ECERS-3 Item 22 Nature/science (n=1063, M=2.54, SD= 1.17), in comparison, LatinX educator-led classrooms fared (n=9, M = 3.22, SD=1.72). In this studies population, LatinX educators scores varied with their level of education: Associates (n=1, M=2.00, min=2.00), Bachelors (n=7, M=2.86, SD=1.06, min= 1.00, max=4.00), and Masters (n=1, M=7, min=7.00). The sample size limits the study; however, findings show a pattern of high-quality growth as educators' higher education achievement is attained. However, this study cannot disregard other potential score variations, like quality improvements, curriculum fidelity, or classroom size. See Appendix B.

4.1.3 CLASS® Instructional Support Domain

First, there is a pressing need to identify the threshold level in the quality of educator-child interactions relating to better child outcomes in the ECE community. Studies suggest children acquire academic skills when achieving cut-off points of 2.75, 3.00, 3.25 on the *CLASS®* Instructional Support (IS) domain (Burchinal, Vandergrift, Pianta, & Mashburn, 2010; Burchinal, Xue, Tien, Auger, & Mashburn, 2011). Children score higher on child outcome gains in classrooms with high-or moderate-level instructional practices than children at or below an Instructional Support threshold of 2.75 (Burchinal, Xue, Tien, Auger, & Mashburn, 2011). A linear association assumes that as classroom quality increases, child outcomes increase proportionally, limiting our understanding of quality thresholds (Weiland, Ulvestad, Sachs, & Yoshikawa, 2013). Further, Weiland and colleagues (2013), to increase the study's variability, use an Instructional Support threshold of 5, showing stronger predictors of classroom quality. In short, threshold quality is the minimum observed scores for cognitive growth and development needed for children's growth (Early et al., 2017).

I referred to OHS CLASS® Descriptive Statistics National Grantee-Level Scores for 2019; IS score of 2.91 in selecting a threshold. I chose a 3.0 threshold as it is representative, at a national level, of the Head Start preschool program performance. It is important to note that if a program receives a score below the competitive threshold for one or more of the CLASS® domains, it must compete for continued funding. In short, the funding of a program is compromised, and educator positions are placed at risk. As aforementioned, instructional support, as measured by CLASS®, evaluates educator-child conversation facilitating emergent scientific reasoning. In LatinX educator led classrooms (N=9), a mean of 2.51 and an SD of 0.65. The NIEER's year four (2018-2019) SPP and SPP Pathway impact evaluation study shows a mean of 3.18 (N=73) and an SD of 0.85. In other words, LatinX led classrooms are scoring less half a point when comparing the mean and the IS threshold of 3.0. Figure 4 shows that only 3 out of 9 LatinX educators met the 3.0 IS threshold.

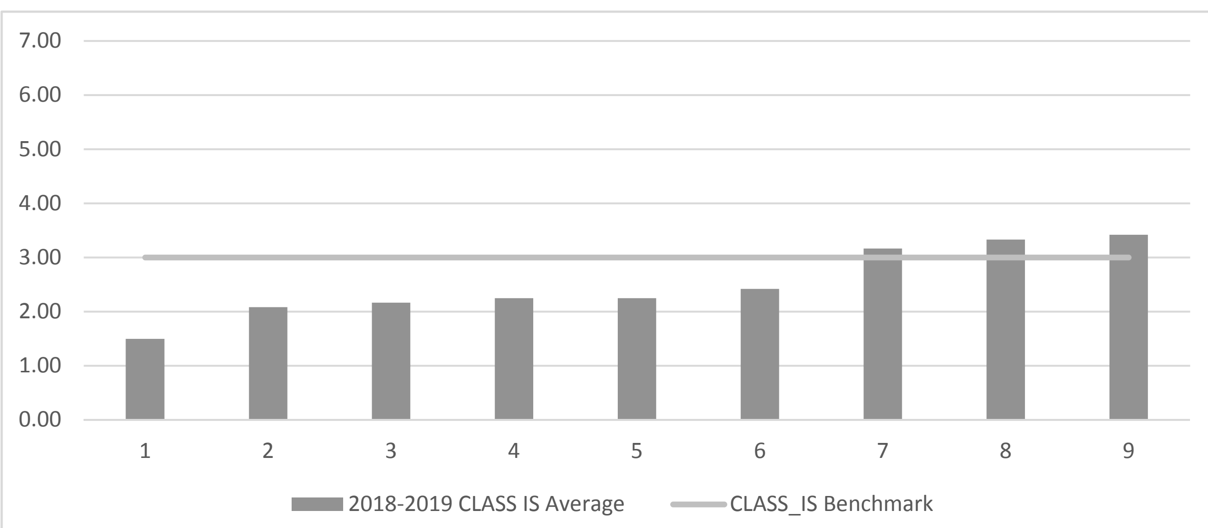


Figure 4. Analysis of LatinX educators meeting a 3.0 IS threshold (N=9).

As aforementioned, as educators attain a higher level of education and with continued quality supports, research shows growth in educator-child conversations (Burchinal, Vandergrift, Pianta, & Mashburn, 2010; Burchinal, Xue, Tien, Auger, & Mashburn, 201). Research also indicates that Spanish-speaking 4-year-old children with more instruction in Spanish showed growth in cognitive development (Bruchinal, Field, Lopez, Howes, & Pianta, 2012). Head Start primarily serves low-income children and their families and estimates that approximately 30% of their enrollees are English language learners (Office of Head Start, 2014). In other words, English is not their home language. Yet, if the use of educator home language influences educator score.

Moreover, it is unclear from the data the level of comfort of LatinX led classrooms with English/Spanish or if they used their wealth of knowledge (Yosso, 2005). It is most perplexing that Table 9 does not show a growth pattern with LatinX educator education achievement level: Associates (n=1, M=1.5, min=1.5), Bachelors (n=7, M=2.67, SD=0.60, min= 2.08, max=3.42), and Masters (n=1, M=2.42, min=2.42). It is unclear why this difference exists across quality assessment tools. A possible explanation could be a difference in tool adaption concerning cultural issues and differences in quality aspect understandings (Garvis, Sheridan, Williams, & Mellgren, 2017). Similarly, Early and colleagues (2018) argue “no single tool exists for measuring all important aspects of quality.” What is clear is that quality nuances across settings need to be researched further to make implications for theory, practice, and QRIS policy. See Appendix C.

4.2 LatinX Educators’ Understandings and Discussion of Early Science

Participants share the importance of education with the following *dicho*: *La educación empieza en la casa. Se desarrolla en la escuela. Y termina a lo largo de la vida de los niños.*

Nosotros como maestros empezamos a desarrollar su enseñanza para que lo apliquen. No solamente es aprender o adquirir información. Es desarrollar habilidades de los niños. **English translation**: Education begins at home. [Education] develops in schools. [Education] continues throughout the lives of our children. We as educators begin to build our teaching so [children] apply [what they learn]. It is not only learning or acquiring information. It is to develop children's skills.

As a reminder, I will evaluate data for **"Teaching and Learning"** and **"Knowledge, Values, and Beliefs"** through thematic analysis." Teaching and Learning measure educators' comfort with planning and demonstrating different science activities. Knowledge, Values, and Beliefs measure educators' understanding and discussions of early science; including their discomfort or concerns and how early science fosters children's interest in science and improves school readiness. These overarching themes are later concept mapped in Figure 7 Evidence Regarding Early Science and the Voices of Seven LatinX Educators by educator comfort, educator challenges, and child benefit (i.e., Tu, 2006; Tu & Hsiao 2006, Nayfeld et al., 2001; Pendergast et al., 2007; Maier, Greenfield, Bulotsky-Shearer, 2013, Greenfield et al., 2009; Edwards & Loveridge, 2011; Pendergast et al., 2007).

First, LatinX educators' understandings and discussions of early science suggest that higher education achievement is linked to educational attainment. For example, educators indicate that they became aware of their cultural wealth (Yosso, 2005). At the same time educators believe that education attainment is not the only path to enhance their educator practices. I believe educators' funds of knowledge (González, Moll, & Amanti, 2005; Gutiérrez & Rogoff, 2003; Rogoff, 2003), cultural wealth (Yosso, 2005), and repertories of practices (Nasir, Rosebery, Warren and Lee, 2006) are traditionally seen outside of meaningful learning by institutionalized settings. When LatinX educators' sense-making practices (i.e., values, knowledge, and beliefs) remain invisible, educators facilitate science activity, and conversations are not validated. When this happens, quality assessment standards and continuous quality improvement are narrow and shallow impacting child gains. In other words, if we do not see, we cannot measure; if we cannot measure, we cannot support; if we cannot support educators, then children are left behind. Also, educators are unaware of HSELOF or WA-ELG, and even if they were, the resources wouldn't be useful as they prefer resources in Spanish. Furthermore, I have learned they struggled with the use and application of technology. Regardless, educators believe early science is important and ask for continuous quality improvement efforts to focus on early science. Specifically, educators want support on how to support children's exploration and thinking about our natural, physical, and spiritual world.

4.2.1 What are the characteristics of LatinX educators?

Evidence regarding the associations of education level and classroom quality indicates that higher educator qualifications are linked to higher quality (Burchinal, Cryer, Clifford & Howes, 2002; NICHD ECCRN, 2002, Barnett, 2003; Hestenes et al., 2019). In addition, EA participants receive quality improvements, professional development, and training to enhance the low quality of early childhood programming (Early et al., 2017). All seven educators have been in the US for at least fifteen years or more. There were seven participants in our thinking group. The preferred language breakdown is 43% and 57%, English and Spanish, and Spanish only. Out of the seven participants, two identified as White, and five identified as LatinX. Two educators teach at family childcare and five at center-based childcare. See Table 11.

Table 11. Survey Responses: Age Range Taught, Educator's Preferred Language, Educator's Teacher Experience, and Education Level (N=7)

Pseudo name	Curriculum	Age Range	Language	Years Teaching	Education Level
Leon	None	Family Child Care	English & Spanish	0-5 years	B.A. or B.S.
Patricia	None	Family Child Care	English & Spanish	20 or more years	Associates
Rocio	Creative	Pre-k	English & Spanish	11-15 years	B.A. or B.S.
Vilma	Creative	Pre-k	Spanish	0-5 years	High School/GED
Juana	Creative	Pre-k	Spanish	11-15 years	B.A. or B.S.
Maricela	Creative	Toddlers	Spanish	20 or more years	Associates
Lucero	Creative	Toddlers	Spanish	0-5 years	CDA

Note: Family Child Care (B-12 years old), Pre-k (3 years-old – before entering Kindergarten), and Toddlers (12 months – 3 years old)

4.2.2 LatinX Educator Survey Responses

Research shows children need to be in classrooms that promote meaningful connections, an environment cultivating children's curiosity and ways to express their ideas, and where educators foster growth and learning (Sarche & Whitesell, 2012). We also know that ECERS-3 Item 22 Nature/science and CLASS Instructional Support are valuable ways to measure a preschoolers' emerging scientific reasoning. Pulling from this research, the second question I ask is how do LatinX educators, part of the diaspora, describe their science teaching and lived experiences?

I'd like to start this section by sharing a common interest across participants: "*educación es una pequeña semilla, que se planta cuando somos pequeños, pero se debe regar toda la vida*." **English translation:** education is a small seed, which is planted when we are little, but it must be watered throughout life. As LatinX educators it is important to achieve our common goal of "*día a día de estar actualizadas para poder ayudar a los niños y que generen compromiso con lo que aprenden de pequeños.*" ***English translation:*** *day by day to be competent to be able to help children to generate commitment to what they learn as children.* Our cultural expression is important for our teaching and learning approach; LatinX educators believe "*aprender no es solamente adquirir información es desarrollar habilidades.*" **English translation:** learning is not only acquiring information, but it is also developing skills.

Teaching and Learning: *Educator's Coaching Experiences and Comfort Level to Engage in Learning Centers*

LatinX educators' survey response patterns suggest they have varied experiences with early science continuous quality improvement. Moreover, educators' comfort level to facilitate emerging scientific reasoning with children across classroom centers also varies. Taking these findings into account, it emphasizes a need for continuous quality improvement efforts to broker LatinX educators' lived experiences at the forefront of educator teacher and learning.

Table 11 and Figure 5 show LatinX educators' coaching experiences and their time to enhance early science professional development. The data shows professional development is variable and inconsistent to support science teaching and learning practices (Pintó, 2005). 47% of educators (N=7) do not receive ongoing professional development specific to science.

Table 11. Survey Responses: LatinX Educators Coaching Experiences (N=7)

Coaching Hours a Month	Percent of Coaching Hour Taking Place a Month	Percent of Coaching Hours a Month Dedicated to Science
0 - 2 hours	29%	29%
3 - 4 hours	0%	14%
4 - 6 hours	0%	0%
6 - 8 hours	29%	0%
8 or more hours	14%	0%
None	29%	47%

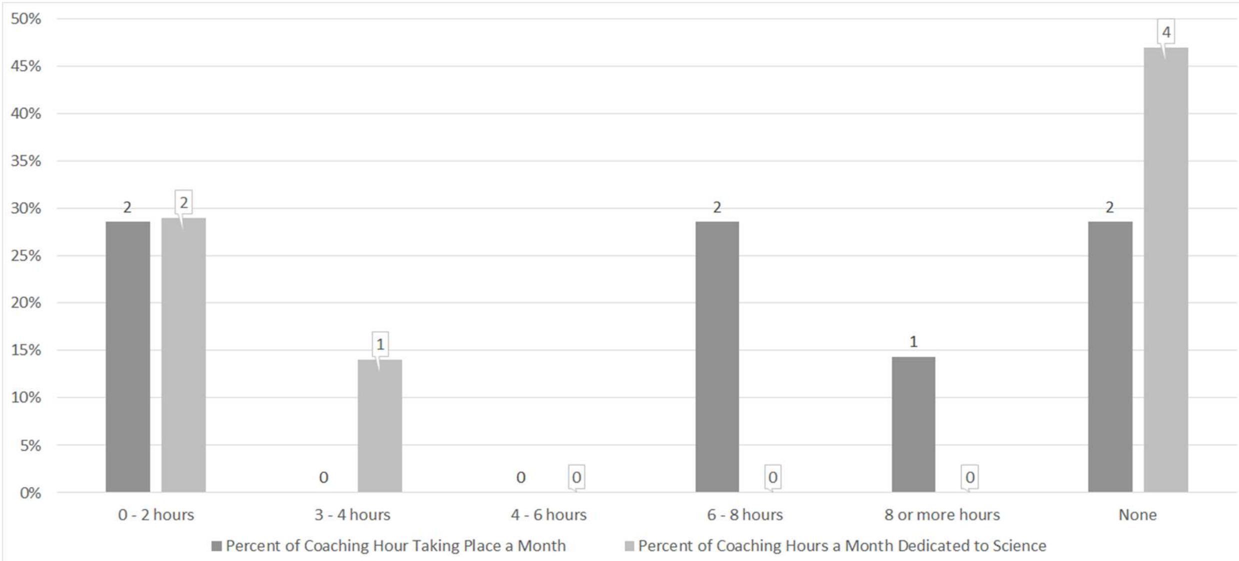


Figure 5. Survey Responses: LatinX Educators' Coaching Experiences

Figure 6 captures LatinX educators' comfort level to facilitate emerging scientific reasoning with children. Arts and crafts are where scientific reasoning occurs the most, and Furnishings and Relaxation are not seen as a center to facilitate science teaching and learning. Surprisingly, Nature/science, Sensory (Sand/Water), Outdoors, and Meals/snacks do not reflect an educator's comfort of 100%. It is critical to emphasize educators show minimal comfort in bridging scientific reasoning in Promoting Acceptance for Culture and Diversity and Child-related display.

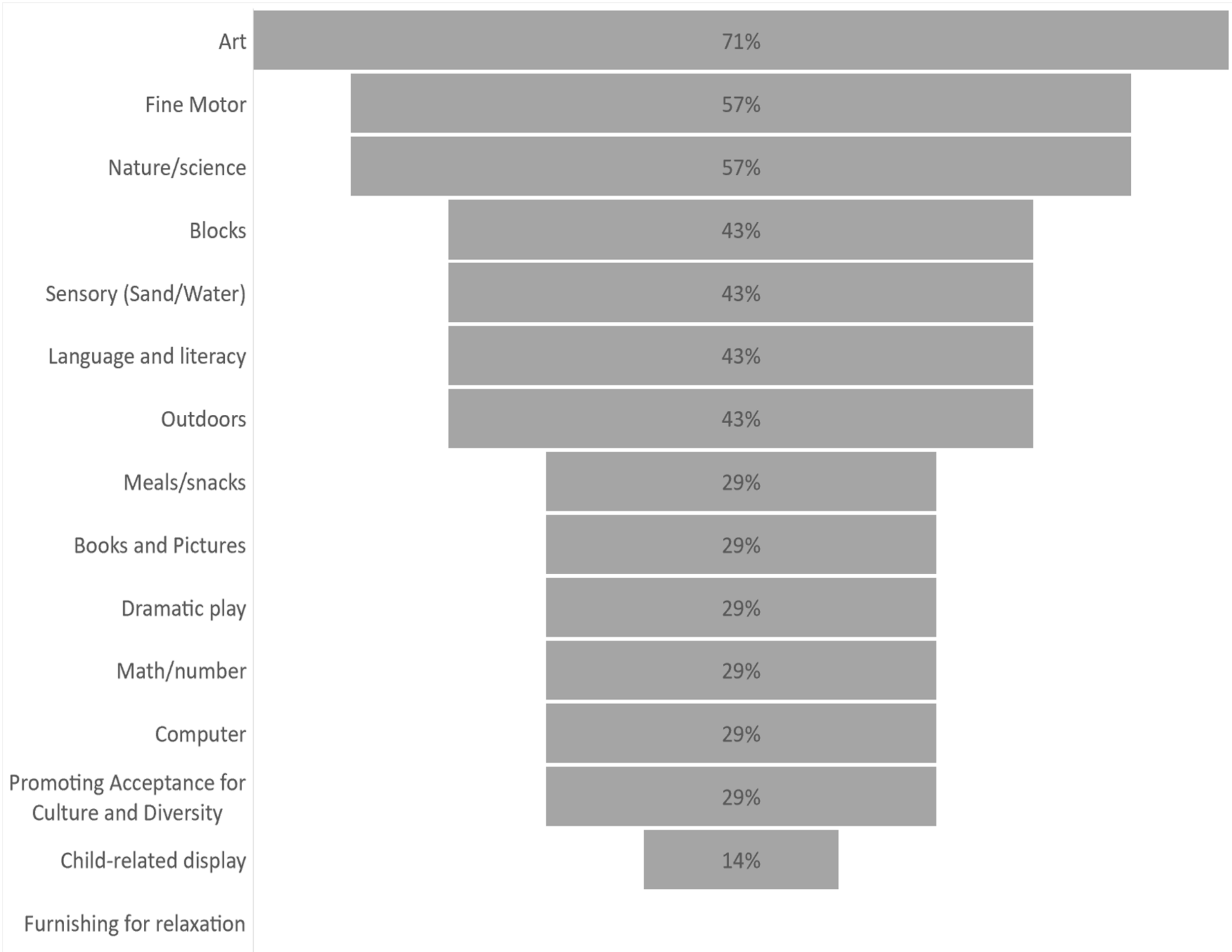


Figure 6. Survey Responses: LatinX Educators' Comfort Level of Learning Centers where they can Engage in Science Conversations

Research shows quality improvements, professional development, and training, vary for educators (i.e., Tu, 2006; Tu & Hsiao 2006, Nayfeld et al., 2001; Pendergast et al., 2007). At the same time, educators ask for more training specific to science (i.e., Maier, Greenfield, Bulotsky-Shearer, 2013, Greenfield et al., 2009; Edwards & Loveridge, 2011; Pendergast et al., 2007). Pulling from this research, we also know the importance of educator comfort, educator challenges, and child benefit on the quality of educator-child conversation promoting scientific reasoning. Equally important is that the classroom is set up with the appropriate learning materials (Tu, 2006; Nayfeld et al., 2001). Thus, a potential reason LatinX educator science self-efficacy and competence may vary is quality improvements and their education level (Burchinal, Cryer, Clifford & Howes, 2002; NICHD ECCRN, 2002, Barnett, 2003; Hestenes et al., 2019). In short, LatinX educators have varying levels of education and unique experiences that vary from the norm. Hence, research, practice, and QRIS policy need to consider nuances in education levels and the effectiveness of quality improvements.

Knowledge, Values, and Beliefs: *Teaching, Daily Expectations, and Early Learning Guidelines Affect Early Science Facilitation*

During the educator thinking group, LatinX educators discuss their discomfort or concern with other daily routines and responsibilities taking away from their facilitation of early science exploration. A few themes emerged about when a child's learning and play are most important for kindergarten readiness. Educators also shared their understanding of why learning through play matters and not knowing about educator guidelines. Furthermore, educators discuss the importance of making resources available in their mother tongue to be helpful.

A few topics resonated among the group, including their beliefs about quality care and education. Educators feel it is essential to focus on schedules and routines, behavior guidance, gross motor development, individualization, circle time, and social-emotional development. For the most part, they believe circle time is when most teaching prepares children for kindergarten. Educators are talking about *structural features* and the *classroom process* of quality – the marriage of both is essential for educator-child conversations and child gains (Justice, Mashburh, Hamre, & Pianta 2008). All educators mentioned and focused on behavior guidance as a necessary prerequisite to their teaching and learning. Educators in centers believe family childcare centers have more flexibility to rearrange their schedules and be more responsive to children's needs. Educators in centers teach in a program open eleven hours and a half, dedicate two hours to free-play and an hour-and-a-half outdoor play. Educators go outside regardless of weather conditions. Patricia y Leon, who works at a family childcare center, agrees with the importance of a routine and a schedule. Patricia also adds, “children learn most during free-play, but I do not know why.” Patricia adds she does not want to go outside when it is raining because parents do not want their children to get wet. All educators believe outdoor play develops gross motor, fine motor, social-emotional, literacy, and reading. It is important to note that all educators do not recognize Head Start Early Learning Outcome Framework (HSELOF) or Washington- Early Learning Guidelines (WA-ELG) as a resource to enhance their educator practices.

Maricela adds, “if only in English. It will not help us.” Lucero nods her head in agreement. It is important to note that Maricela and Lucero, the two toddler educators’ participate with their body language. It might be the combination of being most comfortable speaking in Spanish because Roció, Vilma, Juana, Maricela, and Lucero all know one another. Their stories resonate with one another. Educators express a need for resources and teaching materials in their language to impact their growth and development. The guiding prompts below underscore the importance of community knowledge and the need to radicalize a **f**act to value educators' personal, academic, and lived experiences.

4.2.3 Do educators believe teaching early scientific reasoning matters?

Young children have foundational competence in science before entering kindergarten (Epstein, 2003; Epstein, 2006; Epstein, 2007). In addition, children are motivated to explore scientific reasoning they encounter in everyday interactions with the natural, physical, and social world (Conezio & French, 2002; Brenneman & Louro; 2008). Therefore, educators need adequate preparation to understand and integrate scientific reasoning into their teaching practice (Nayfeld, Brenneman, & Gelman, 2008). It is important to note that research shows preschool educators believe teaching early scientific reasoning matters (i.e., Greenfield et al., 2009;

Nayfeld et al., 2011; Edwards & Loveridege, 2011; Pendergast et al., 2017). See Appendix A. Pulling from this research; there is a literature gap on whether LatinX preschool educators think similarly. The section below explores LatinX educators' beliefs and understandings about young children's engagement with science, regardless of participation in EA.

Knowledge, Values, and Beliefs: *Young Children Make Sense of the World Around US in Sophisticated Ways*

During our thinking groups, LatinX educators share their understandings of why early science matters. All educators believe that science begins with infants and that a child's lived experiences build on their prior knowledge. Furthermore, educators discuss the importance of asking open-ended questions during play, inside and outside, to prepare children for kindergarten. At the same time, educators share they need support with asking open-ended questions related to a child's interest and play. I believe educators are making sense of new knowledge (open-ended questions) and how it relates to their current knowledge.

Prompt:¿Es importante enseñar la ciencia en la primera infancia?

English translation: Is it important to teach science in early childhood?

All educators agree teaching science early on is essential and young children can make sense of our world (i.e., Greenfield et al., 2009; Maier, Maier, Greenfield, & Bulotsky-Shearer, 2013). In addition, all educators believe infants, toddlers, and preschool children investigate and participate in the process of inquiry and scientific activities influencing long-term attitudes towards science education (i.e., Maier, Greenfield, & Bulotsky-Shearer, 2013; Fleer & Gomez, 2014). Finally, León shares that as children progress from grades, they learn more and more, and we start early because of this. Roció adds:

> Roció: "Yo pienso que desde niños nosotros les enseñamos ciencia para que ellos cuando van creciendo en cada etapa ellos ya van sabiendo… que la ciencia esta alrededor de nosotros."

> **English translation:** I think that since childhood, we teach them science so that when they grow up in each stage, they already know ... that science is around us.

Educators engage in open-ended materials or activities that children can use appropriately in their way—an outcome not predetermined by the staff or the material itself. Educators discuss the importance of asking "why" and "how" questions. Educators practice reasoning, understanding, and language development (CLASS®, Pianta, La Paro, & Hamre, 2008). For example, an educator shares during their circle time, read a book, and afterward asks children, "what did you understand? What did you like? Why?"

> Patricia: "Well, the tools for science teach them how to analyze the subject, how to make a prediction. And to… for the outcome. So that is how we apply the science at home to get… their analysis. And they start at a young age… make questions, analyze and make predictions, and teach them at an early age."

Simultaneously, Patricia asks for support on how to bring open-ended questions to children. "I ask it the wrong way… I need help to get to the Why? How?" Rocio shares: start by introducing the materials, and children will play in their way. It is here where you can combine vocabulary and knowledge. At this point, Patricia recalled nature walks she and Leon, her husband, do with the children. When Rocio shares her experience, Patricia connects nature walks to be science.

> Rocio: "Podemos hacer diferentes preguntas para que ellos tengan mas palabras y se puedan hacer preguntas abiertas."

> **English translation:** We can ask different questions so that they have more words and ask open questions.

> Juana: Nosotros decidimos dónde sentarnos dependiendo de las necesidades del niño. Cuando estamos afuera, nosotros caminamos alrededor de nuestra comunidad y exploramos las plantas creciendo en el patio, los niños juegan con la tierra y observan las lombrices, o las mariposas — *[Maricela and Lucero nod in agreement]*.

> **English translation:** We decide where to sit depending on the child's needs. When we are outside, we walk around our community and explore the plants growing in the yard; the children play with the dirt and observe the worms or the butterflies.

> Patricia: We have an ant farm on a tree. We show the children how old it is by counting lines on the trunk. We also teach how long trees and ants live. We then go to the computer and find out more information about the subject.
>
> Leon: "We have a pond and ducks. We go on nature walks. We have a trunk decomposing over time… we notice. Not too far away, there is another tree. I show them how they can determine the age of the tree."

From research, we know educators "who are unsure or have misconceptions of what science still supports children's working theory around the nature of science, whether they are aware of it or not" (Edwards & Loveridge, 2011). Findings are similar to prior studies (Maier, Greenfield, Bulotsky-Shearer, 2013; Pendergast, Liberman-Betz, & Vail, 2017), where educators felt "children are curious about scientific concepts and phenomena, and felt preschool science foster an interest in science later in life."

4.2.4 Where are some places educators learn about science?

As aforementioned, research shows, children understand aspects of the life cycle of plants and animals (Medin & Bang, 2010; Medin & Atran, 1996). In addition, research shows that educator beliefs and attitudes about educator comfort, educator challenges, and child benefit influence their engagement with scientific reasoning. See Appendix A. For example, educator-child conversations are guided by the classroom environment to cultivate instructional support conversations (i.e., Tu, 2006; Tu & Hsiao, 2008, etc.). Pulling from this research, we do not know LatinX educators' understandings. Therefore, the following section explores LatinX teaching and lived experiences to make sense of science as part of our everyday lives.

Teaching and Learning & Knowledge, Values, and Beliefs: *Crosscutting Concepts - The Value, History, and Science of the Tortilla*

Educators shared that they can facilitate emergent science from reading books, dramatic play, music, art, math, and nature during our thinking groups. They also describe research and investigation by looking up information on the web. During our conversation about where science occurs, educators begin to talk about what they believe Kindergan educators want Kindergarten children to know. Furthermore, the group discusses the value of their mother tongue and their experiences living in the United States. Then the group has a conversation about the value, culture, and history of the tortilla and their thoughts as kids to now as adults. Next, we discuss the impact we humans have on our world and our responsibility to our plant and animal relatives. Our conversation progressed to the importance of celebrations, and that science learning can happen in these contexts. Educators' understanding and discussions suggest a single image does not bind science. It also indicates that LatinX educators think about science learning and teaching from a broader perspective, crosscutting concepts. In a way, our discussions deepen our understanding that LatinX educators are thinking of science beyond the classroom. In other words, while the survey patterns suggest a need to dedicate more time to center play areas, our conversations suggest our image of science needs to be broadened to include LatinX educators' lived experiences.

> *Prompt: Me acordé de que Juana está hablando de tortillas. Eso es muy específico a latinos. ¿Es esto ciencia?*
>
> **English translation:** I remember Juana is talking about tortillas. That is very specific to Latinos. Is this science?

First, our notion of "when is science" expands when we consider the "interests of the children, parents, other educators, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives" (Edwards & Loveridge, 2011). Senator John McCoy is speaking to Senate Bill 6474 to improve education for schools. We need to utilize our tribal schools to educate our children. The Western model and way of teaching science are not better than the native way. We have different values and ways of thinking. John McCoy (2018) “I don’t want to be like you.” There is a percolating fear of teaching children their culture, language, and heritage. All educators agreed with Patricia when she shared: She and her husband follow what the school district asks. The kindergarten educators say what is essential to teach: reading and literature, fine motor, and gross motor skills. Kindergarten educators do not have the time to tie twenty-two shoes and focus entirely on behavior guidance. Patricia shares that her kids do not know Spanish because the education system believed it would stunt their language development to learn two languages simultaneously. “My children did not learn Spanish. My husband was afraid to teach our kids. So, they can learn English. My grandchildren only go to daycare that only speaks Spanish.”

Concurrently, Rocio shares her thesis in Dual Language Learners. She works with teenagers, all LatinX, and none of them want to speak Spanish. In a way, Rocio’s words comfort Patricia’s pain. Patricia adds, “I want to connect and be a part of the LatinX customs and celebrations, cultures, and especially learn to cook the food.” Educators encourage Patricia to attend evening sessions on cooking traditional foods, learning Spanish, and celebrating traditions and customs. Educator discussions highlight a contradiction between norms, institutional systems of power and oppression, and the consequences of not having a voice (Callison, 2014; Bakhtin, 1986; Edwards, 2005).

Second, educators connect science as a crosscutting process and content, teaching “valor, cultura, la historia de la tortilla.” Educators follow a process when teaching “1) Introduce material or subject, 2) Watch what they are doing, 3) Ask questions to expand the play-act, 4) Art – Music – Read we ask questions, and 5) Go for nature walks – discuss – return home expand on the subject – look up info on the computer” (i.e., Tu & Hsia 2008, Greenfield et al., 2009, Edwards and Loveridge, 2011, etc.). Educators discuss their knowledge and experiences teaching early science below:

> Vilma. "Si. A mí me gusta el libro de la oruga. Como se llama. "The Hungry Caterpillar" Si, ese libro es de matemáticas, de ciencia, de los días de la semana."
>
> **English translation:** I like the caterpillar book. What is [the title of the book]. "The Hungry Caterpillar" Yes, that book is about math, science, the days of the week.
>
> Roció: "También el juego dramático. Yo tengo un set para niños y para niñas. Ellos pueden ser estilistas, cajeras, ser chef… tenemos vestuarios también. Hacer una pizza. Me llevan las cosas. Pretenden trabajar en un restaurante. Ellos me traen el menú. Y nos traen la quesadilla."
>
> **English translation:** Also, the dramatic area. I have a set for boys and girls. They can be stylists, cashiers, and chefs… we have various clothes for children to act out roles. Make a pizza. They bring things to me. They pretend they work in a restaurant. They brought me the menu. And they bring us the quesadilla.
>
> Vilma: Si. Es ciencia, los libros también, la matemática. Estamos midiendo y mezclando la harina con el agua. En nuestro salón estamos haciendo tortillas. [Vilma, uses her hands to make the familiar sound with her hands of making tortillas]. Entonces estamos enseñando las ciencias….
>
> **English translation:** Yes. It is science, books too, mathematics. We are measuring and mixing the flour with the water. In our living room, we make tortillas—[Vilma, use her hands to make the familiar sound with her hands while making tortillas]. So we are teaching science…

We make sense of the social, natural, and physical worlds in meaningful and sophisticated ways (Cajete, 2000; NRC, 2012). Our ethical responsibility is providing educators the space to deconstruct notions of "what is science" and "when is science" while rethinking possible futures of science (Cajete, 2000, Bang, Warren, Rosebery, & Medin, 2012; Eberbach & Crowley, 2009; Metz, 1995, Edwards & Loveridge 2011).

Next, research indicates emerging scientific reasoning is process and content (Bybee, 2011). Teaching scientific content without process results in an incomplete and isolated understanding of science (NGSS, 2018). For example, Juana shares her lived experiences learning to cook tortillas with her mom.

> Juana: Bueno, antes cuando era niña. Cuando mi mamá me ponía hacerlas. Como no figura lo que está aprendiendo ves… [Juana begins to laugh and everyone's laughter joins hers]. Yo tenía mi bolita. Y también está practicando el motor fino. Porque usaba las manos, los dedos, haciendo mi bolita de masa. Lo que pasa es que yo no sabía — [Roció, Vilma, Maricela, and Lucero nod their heads in agreement].
>
> **English translation:** Well, back when I was a kid. When my mom made me do them, I did not realize what we were learning, you see… [Juana begins to laugh, and everyone's laughter joins hers]. I had my ball. And I was also practicing fine motoring. Because I used my hands, my fingers, and made my ball of flour. What happens is that I did not know — [Roció, Vilma, Maricela, and Lucero nod their heads in agreement].
>
> Prompt: Juana, comentaste que no sabías. ¿Qué es lo pudiera haber hecho tu mama para conectar que lo que estabas haciendo es ciencia? ¿O tú lo haces con los niños en tu clase?
>
> **English translation:** Juana, you said you didn't know. What could your mom have done to connect that what you were doing is science? Or do you do it with the kids in your class?
>
> Juana: Si. Ahora, si lo hago. Porque he tenido educación. Pero en ese entonces lo que mi mama… es que… ella tampoco lo sabía. Bueno la educación y mis experiencias nos hace crecer… No sabía que mi mamá me estaba dando ciencia — [Roció, Vilma, Maricela, and Lucero nod their heads in agreement].
>
> **English translation:** Yes. Now, if I do. Because I've had an education. But back then what my mom... It's just... she didn't know either. Well, education and my experiences make us grow... I didn't know my mom was giving me science — [Roció, Vilma, Maricela, and Lucero nod their heads in agreement].
>
> Leon summarizes in English: So, her things when she was doing science. But you didn't think about it that way. Because at that time, parents didn't have formal science training. But now, as an educator, she understands the connection and can share that with her kids.

In contrast to prior research (Tu, 2006; Tu & Hsiao, 2008), educators seek opportunities to bring science into reading a book, dramatic play, math (counting, mixing, etc.). In other words, LatinX educators share their ways of making sense of science with young children. It is important to note, Juana did not conceptualize that cooking tortillas is learning and doing science. It wasn't until she sought higher education that she was aware of her scientific background. Such realization is essential for Juana to be responsive to bridge scientific reasoning to children's lived experiences.

Moreover, LatinX educators agree that the value of life is to take care of our plant and animal relatives. Therefore, we can be more conscious of recycling and be aware that transportation and building infrastructure impact our society. Also, Roció, Vilma, Juana, Maricela, and Lucero agree it is essential to explain what we celebrate and why. Juana add: "Explicar acerca de la justicia social y claro siempre al nivel educativo de cada edad."

> El día del niño que el 30 de abril, les explicamos porque festejamos el 30 de abril, que es el día del niño y que son importante porque es un día feliz para ellos y así se van motivando y lo que aprendemos con ellos les ayuda para que en su futuro ellos lo van aprender, hacemos fiesta para ellos celebrarlos es un día muy especial.
>
> Nuestra actividad del día de los muertos es explicarles a los niños sobre la cultura y decirles el ciclo de la vida. A veces muchos niños llegan tristes por la pérdida de un familiar y es cuando les leemos algún libro relacionado a esto.
>
> **English Translation:** Children's Day on April 30, we explain to them why we celebrate April 30, which is Children's Day, and that they are important because it is a happy day for them and thus they are motivated and what we learn with them helps them to that in their future they will understand it, we make a party for them to celebrate it is a very special day.
>
> Our day of the dead activity explains to children about culture and tells them about the life cycle. Sometimes many children arrive sad because of the loss of a relative, and that is when we read them a book related to this.

Roció, Vilma, Juana, Maricela, and Lucero also believe it is important to share their culture and know about the history: "5 de mayo (vestuarios y música)" and "MLK Day (Justicia Social) – hacer marcha con los niños." LatinX educators shared their beliefs and values and meaningfully connected social justice, history, and lived experiences to scientific reasoning.

4.2.5 Who do educators learn about science from?

First, science learning materials on their own provide learning opportunities for young children. Second, educators need to know children's scientific thinking and learning (Tu 2006; Tu & Hsiao, 2008). Educators are best prepared to identify science learning, assess what a child knows or needs to know about a concept, and plan for more instructional support by understanding children's scientific reasoning development. Third, it is essential to note that ECE educators consider science challenging to teach. See Appendix A. However, this is not surprising. Educators usually are not prepared to teach domain-specific knowledge to young children. It is important to note that educators ask for quality improvement specific to science education to bring about meaningful content knowledge and teaching practices. Pulling this research, it is less known about LatinX educators' teaching and lived experiences related to their continuous professional development. The following section explores LatinX educators' understanding of where and whom they learn science from.

Teaching and Learning & Knowledge, Values, and Beliefs: *Pathways to Science: Higher Education and Lived Experiences*

During our conversation, educators shared the importance of matching their teaching to a child's learning and development. Some educators believe that academic achievement has helped them with their educator-child practices. Other educators agree academic achievement is essential and is not the only pathway to enhance their educator-child practices. Next, educators discuss technology as a critical tool that can strengthen science knowledge and understanding. However, technology can also be a detractor from children engaging with the natural world around them. Our conversation grew into educators' knowledge of why nondominant children engage differently with materials than their counterparts. Educators' discussions suggest academic attainment is not the only pathway to continuous quality improvement. However, data also indicate that LatinX educators fare better in quality assessment standards with educational attainment. Educators also share their beliefs of children's varying levels of engagement with technology and the natural world depending on their racial background. Technology is seen both as a resource to expand science teaching and learning and a detractor from it. These discussions suggest that LatinX educators need continuous quality improvement support beyond requiring academic achievement alone. However, survey data also shows that educators' coaching is varied and infrequent, especially regarding science.

> *Prompt: ¿Se debe tener conocimiento para enseñarle a los niños sobre la ciencia? ¿Qué conocimientos o experiencias son importantes?*
>
> **English translation:** Do you have to know science to teach children about science? What knowledge or experiences are important?

LatinX educators reflect their experiences with higher education as the turning point to see their experiences connected with science inquiry. The conversation below underscores the disconnect between institutional systems of power not recognizing and valuing nondominant communities' ways of being (Bang, Brown, Calabrese Barton, Rosebery & Warren, 2017; Yosso, 2005; Banks, 2007).

> Vilma: La ciencia al nivel de los niños se aprende en todos lados, como medir, mezclar los colores, la arena. Eso es ciencia. Nosotros tenemos el CDA y por eso seguimos expa él BA. [*Vilma is speaking for Roció, Juana, Maricela, and Lucero. All of which nod their heads in agreement. It is important to enhance their education]*.
>
> **English translation:** Science at the children's level is learned everywhere, like measuring, mixing colors, and sand. That is science. We have the CDA, and that is why we follow the BA.
>
> Patricia: Well, she is mentioning education. A degree. You asked what background or tools we need to be able to teach science.

Prompt: *Patricia está hablando de un punto interesante. ¿Nosotros solamente aprendemos y enseñamos la ciencia de un sistema educativo?*

English translation: Patricia, you are bringing up an interesting point. Do we only learn about and teach science from an education system?

León: No. No, no, no. Por ejemplo, cuando los niños tienen interés… como los dinosaurios. Nosotros podemos usar un libro o enseñarles un video sobre dinosaurios para que aprendan más.

English translation: No. No, no, no. For example, when children have an interest... like dinosaurs. We can use a book or show them a video about dinosaurs to help them learn more.

Most perplexing is that Juana did not see her experiences with her mother making tortillas as science. First, we know that nondominant children's cultural practices are outside meaningful learning (Stromholt & Bell, 2017; Yosso, 2005; Medin & Bang, 2005). Second, we also know educators show discomfort with facilitating scientific reasoning (i.e., Tu 2006, Tu & Hsiao, 2008, Greenfield et al., 2009; Maier, Greenfield, & Bulotsky-Shearer, 2013). Finally, we also know educators do not see their knowledge as science (Edwards & Loveridge, 2011). Thus, it was shocking that educators connected their childhood experiences to science until they pursued higher education.

LatinX educators indicate they did not have technology at their disposal in their childhood experiences. However, now they can use technology to bring science into their day-to-day conversation with children. If they do not know an answer to a question, they can seek the answers using technology (Tu & Hsiao, 2008).

Juana: En tiempos atrás no había teléfono ni tabletas. Uno salía y allí encontrabas la ciencia. Jugabas con el lodo, la tierra, mezclamos el agua con la tierra. Y después vimos las lombrices. Eso, ahora se que es ciencia. Todo lo de afuera, tú puedes enseñar la ciencia.

English translation: In the old days, there were no phones or tablets. You would go out and there you would find science. You played with the mud, the earth, you mixed the water with the earth. And then you track the worms. So now I know it's science. Everything outside, you can teach science.

Vilma: Cómo cocinar, medimos eso es ciencia. Lo de mezclar la arena con el agua. Eso ya es ciencia. ¿No? Ahora es mucho de la tecnología.

English translation: Like cooking, we measure that it is science. The thing about mixing the sand with the water. That is already science. Right? Now it's a lot of technology.

Prompt: *¿Ustedes piensan que es importante tener conocimiento con la naturaleza teniendo experiencias y no solamente aprender viendo la pantalla?*

English translation: Do you think it is important to engage with the world around us through experiences and not just learn it through a screen?

Vilma: Si, si pienso que se pueden combinarlas. Por ejemplo, podemos poner el YouTube o el Bluetooth para la música. Al nivel del preescolar, los niños usan la tecnología.

English translation: Yes, I think they can be combined. For example, we can use YouTube or BlueTooth for music. At the preschool level, children use technology.

In addition, research indicates technology and music are integral components for children's learning and development (Harms & Clifford, 1989; Burchinal & Cryer, 2003). Educators bring to the forefront their ability to engage in cross-cutting concepts when teaching science (NGSS, 2011; Ambitious Science, 2018). Educators also see technology as a barrier for some children to engage with the natural world. Technology can interfere with a child's play and learning with dirt and water to make mud, take care of plants and animals, and how our infrastructure impacts our world.

Roció and Vilma, from the same center, discuss children's engagement with nature. They highlight differences in engagement, and potential reasons for this, between LatinX and white children. Research shows "gross motor and physical activity opportunities in early childhood are important for promoting health and development" (Tandon, Hassairi, Soderberg, &

Joseph, 2018). A rich outdoor environment is likely to promote pretend play in children (Li, 2014). We also know nondominant communities have a different engagement with a place (i.e., Morelli, Rogoff, & Angelillo 2003; Medin & Bang 2005; Cajete, 2000; Medin & Bang, 2010). Pulling from this research, what is most interesting is why children do not want to get dirty.

> Roció: En mi experiencia a los niños no les gusta tocar la tierra con agua. Ellos no tienen la experiencia como nosotros de niños. Los niños de hoy no tienen la experiencia de afuera. Si tienen las manos llenas de algo. Se quieren lavar las manos. Son otros tiempos.
>
> **English Translation:** In my experience, children do not like to touch the earth with water. They don't have the experience we did as children. Today's children don't have the experience from the outside. For example, suppose they have their hands full of something. They want to wash their hands of it. These are other times.
>
> Vilma: Bueno, déjame decirte que los niños blancos. Ellos sí, hacen y deshacen. Los niños latinos no se quieren ensuciar. Por ejemplo, si nos ponemos a ver una película. Los niños latinos están atentos. Pero los niños blancos no. Como que a los niños latinos solamente los tienen en la tele o el Tablet — *[Roció, Juana, Maricela, and Lucero nod their heads in agreement. They all work primarily with Latino and White families]*.
>
> **English translation:** Well, let me tell you about white kids. They do, they do, and they undo. Latino kids don't want to get dirty. For example, if we start watching a movie. Latino children are on the lookout. But white kids don't. Like Latino kids only have them on TV or tablet — *[Roció, Juana, Maricela, and Lucero nod their heads in agreement. They all work primarily with Latino and White families]*.
>
> Prompt: *¿Por qué piensan que existe la diferencia de conocimiento entre los niños blanco y latinos? ¿Piensan que nuestro ambiente, rural o urbano, influye como nosotros aprendemos del mundo?*
>
> **English translation:** Why do you think you see the difference in engagement with white and LatinX children? Does our environment, rural or urban, influence how we engage with the world around us?
>
> Vilma: Los niños latinos a lo mejor no tienen la oportunidad porque viven en apartamento y no tienen acceso al campo. Es importante enseñarles a los niños sobre nuestros recursos, como reciclar, y cuidar de nuestro ambiente. Es importante cuidar de la naturaleza, las plantas y los animales.

> **English translation:** Latino children may not have the opportunity because they live in an apartment and do not have access to the countryside. It is important to teach children about our resources, recycle, and take care of our environment. It is important to take care of nature, plants, and animals.

Research indicates educators with a college degree have a higher level of reflection, leading to higher classroom quality (Ying-Chun, & Magnuson, 2018; Zora, 2019; Purtell & Ansari, 2018). Roció and Vilma reflect and identify that access to the natural world is critical for children to build relationships with nature and understand how our actions impact our world. Educators aware of the needs and individual child interests in the classroom are better at creating a classroom environment meeting all children's needs (Ansari & Pianta, 2019).

4.2.6 What professional development and training do you need?

Quality improvement, professional development, coaching, and training are a cornerstone connecting ECE program leaderships (educators/ directors/ family child care providers) with coaching, workshops, technical assistance, and incentives leading to children's learning gains (Quality Compendium, 2017). ECE needs more robust quality improvements to engage young children in developmentally appropriate scientific reasoning effectively. Educators can connect school, home, and other learning environments like; libraries, museums, agriculture, farming, clay work, fishing to support (1) scientific inquiry and (2) reasoning and problem-solving (Stromholt & Bell, 2017; Next Generation Science Standards, 2015; HSELOF, 2015). For QRIS policy, research, and practice to advance scientific reasoning in early childhood, it is necessary to build sustainable and aligned high-quality learning systems from birth to promote kindergarten readiness outcomes (Scott-Little & Reid, 2010; Scott-Little, Kagan, Reid, Sumrall, & Fox, 2014; Kagan, Scott-Little, Reid, & Castillo, 2013; Briseño, Joseph, Bang, and Sanders (2017).

Teaching and Learning & Knowledge, Values, and Beliefs: *LatinX Voices for Continuous Quality Pathways to Science: Higher Education and Lived Experiences*

LatinX educators' understanding and discussions of early science indicate a need for professional development specific to early science. Educators continue to reiterate that resources and training need to be in Spanish. Educators talk about continuous quality improvements being culturally responsive by valuing their lived experiences, knowledge, and understanding.

> *Prompt:¿Qué tipo de desarrollo profesional y capacitación necesitan para tener éxito en enseñar ciencia?*
>
> **English translation:** What kinds of professional development and training do they need to succeed in teaching science?

The importance of home language is a recurring theme for children and educators. Each educator stresses the importance of having resources translated into Spanish. "If only in English. It would not help us." León and Patricia, entrepreneurs of their family childcare business, say, "I need more support on how to bring to the classroom. Science applies to almost everything in higher grades." All educators recognize it is essential to interact and guide a child's development, play, and learning. To bring training knowledge into classroom practice, educators want practical courses to connect theory to practice. "Y más entrenamientos relacionados con la ciencia." Educators share they would like to have more: (1) videos and online classes connected with materials, (2) planning and ideas to integrate learning across contexts, (3) training focuses on evaluation and communication, (4) help with STEAM-ing books, (5) asking open-ended questions during play, and (6) hands-on training with visual guides. A recurring theme is having the institutionalized backing of their experiences counting as science – like making tortillas. A quote that embodies their resilience and their hope is: "You do the best you can with what you have. Now that I know more. I can do better."

4.2.7 How do educator comfort, educator challenges, and child benefit affect educators' self-efficacy and competency?

First, self-efficacy refers to one's attitudes or beliefs about teaching (content and process). Numerous studies underpin competence: "attitudes" and "beliefs" as complex and multidimensional constructs guiding human behavior (e.g., Maier and colleagues, 2013; Pendergast, Lieberman-Betz, Vail, & 2017). Where "attitude" represents an individual's experiences of an object (i.e., content and process aspects of cognition) defined by dichotomous dimensions: positive-negative, favorable-unfavorable, harmful-beneficial, another way to think of an "attitude" is as a "feeling" towards an object (person, place, or thing). Whereas "beliefs" represent information towards an object that may or may not match "fact." Considering that history (stories) represents those in power doing the constructing, it is important to distinguish "facts" with a lower-case f and not an upper-case F. Studies indicate that "attitudes" and "beliefs" are interdependent, in a cyclical relationship of one another. For example, what is thought to be true about an object (belief) will, in turn, influence feelings towards an object (attitude) and vice versa. To illustrate this example, consider when an ECE educator is judging their ability to be lacking knowledge (content and process) of science teaching (belief) will consequently develop a dislike for science teaching (attitude).

Evidence regarding educators' self-efficacy and competency suggests that science educators need to examine their underlying beliefs about teaching and learning scientific reasoning. Educators need multiple opportunities to reframe and redefine their beliefs about educator-child conversations (Yerrick, Parke, & Nugent, 1997). Pajares (1992) argues beliefs are underpinned by personal lived experiences and are difficult to change. Windschitl and colleagues (2007), based on their research into the scientific method, argue educators' belief dominates the conceptual frameworks that both novice and experienced educators use to design investigative science experiences for students. Moreover, Palmer (2006) argues for three concepts underlying self-efficacy. The first, cognitive content mastery, is success in understanding science content. The second cognitive pedagogical mastery is success in understanding how to teach. Finally, simulated modeling is when educators learn about classroom practices through role-playing.

Various challenges influence educators' behavior, impacting instruction frequency, quality, and content across cognitive domains (Wilkins, 2008). For example, Pintó (2005) argues efforts to develop an educator's teaching practices without considering an individual's context are unsuccessful, in contrast to when values and meanings are at the forefront of professional development. Moreover, emphasizing educators can build their understanding through collaborative work make "educator[s] more aware of their ideas and behavior, with a view of effecting lasting change." Otherwise, educators' attitudes and beliefs about teaching and learning remain unchanged. In short, this research shifts the focus of quality improvement from top-down education and learning to a co-constructive space for educators to share knowledge to empower their scientific reasoning competence.

Moreover, Palmer's (2011) research investigating elementary educators indicates that attitudes can be changed and that change is sustained. Specifically, results "showed that increases in self-efficacy were mainly due to cognitive mastery (i.e., perceived success in understanding how to teach science)." For example, educators followed the "investigative sequence" to provide opportunities for learners to "make observations and explanations, propose investigable questions, design and carry out a simple, fair test using everyday materials, and report their findings to the class." The six steps for educators to follow were:

> **Demonstrate:** Through modeling, the educator demonstrates a phenomenon providing hands-on opportunities, and asks learners to describe their observations and to suggest an explanation.

Display: The educator introduces various alternative materials to investigate further and gain knowledge.

Ask: The educator questions and scaffolds a learner's thinking by asking open-ended questions and providing hints/suggestions when needed.

Choose: Through think-pair-share, the educator asks learners to plan what they would like to investigate and measure what they have learned.

Experiment: The educator plans for learners to collect tools, carry out their investigation, and observe what happens.

Report: The educator asks learners to make their thinking visible by sharing the question they are investigating, how they tested their experiment, and what happened.

In other words, this indicates that preschool educators should benefit from a cognitive mastery of scientific reasoning (NGSS, 2015; Ambitious Science, 2018; Greenfield et al., 2009). For quality improvement to enhance educator self-efficacy and competency in scientific reasoning, cognitive mastery is essential. The marriage of content and process and culturally appropriate materials (Pintó, 2005) is necessary to cultivate the care and education of young learners.

Furthermore, evidence regarding preschool educators' self-efficacy and competence in scientific reasoning indicate three concepts influencing change. First, educator comfort measured educators' enjoyment of planning and demonstrating activities across science content areas. Second, educator challenges measured educators' competence toward teaching science, including their discomfort and concerns regarding their ability and science knowledge to engage in science education. Finally, child benefit measures educators' competence regarding whether science is developmentally appropriate for preschoolers, fosters preschoolers' interest in science, and helps improve different school readiness skills. See Table 4 and Appendix C.

Next, Figure 7 is a concept map for LatinX educators' understanding and discussions of early science. The figure is an overview to answer the second question of this study. How do

LatinX educators understand and discuss science teaching? Specifically, How do educator comfort, educator challenges, and child benefit affect educators' self-efficacy and competency? To overview, LatinX educators discuss their comfort and enjoyment of planning and demonstrating activities across content areas when they broker their language, culture, values (Yosso, 2005). They believe we have a social responsibility to take care of our world and those around us by recycling and understanding that our choices affect our world. In addition, educators bring their cultural wealth (Yosso, 2005) that is not otherwise discussed in other research (see Append B).

I argue a need to intentionally explore how quality assessment standards and quality improvements can be adapted with care across contexts, considering cultural issues and variations in our quality (Garvis, Sheridan, Williams & Mellgren 2017). Educators highlight their discomfort with engaging in scientific reasoning. Educators indicate no knowledge of WA-ELG or HSELOF, and even if they did, they would not be able to use the resource as they are not in Spanish. Second, educators' most significant source of discomfort is engaging in an instructional support conversation. They indicate struggling with asking an open-ended question to encourage (1) scientific inquiry and (2) reasoning and problem-solving. Most perplexing is that educators are unaware that their cultural experiences, language, and customs are valuable for teaching.

Finally, all educators agree that early science matters and must begin in ECE in terms of child benefit. In addition, educators believe children enjoy learning about their environment, outdoors or indoors, and engaging in inquiry, reasoning, and problem-solving teaching and practices across centers. Again, though, Figure 6 shows variability in the centers they can teach scientific reasoning, consistent with prior research (Tu, 2006, Tu & Hsiao 2008). Moreover, educators believe that kindergarten educators know best and that they need to focus on children learning to listen and tie their shoes. Perhaps, most perplexing is that educators believe white children and LatinX children engage with their environments differently. They indicate this could be because of financial and environmental factors.

In terms of quality improvements, professional development, coaching, and training, LatinX educators indicate they would like to have more resources and opportunities to grow their capabilities. For example, the survey shows irregular coaching hours (see Table 11) and minimal time explicitly dedicated to developing scientific reasoning competency.

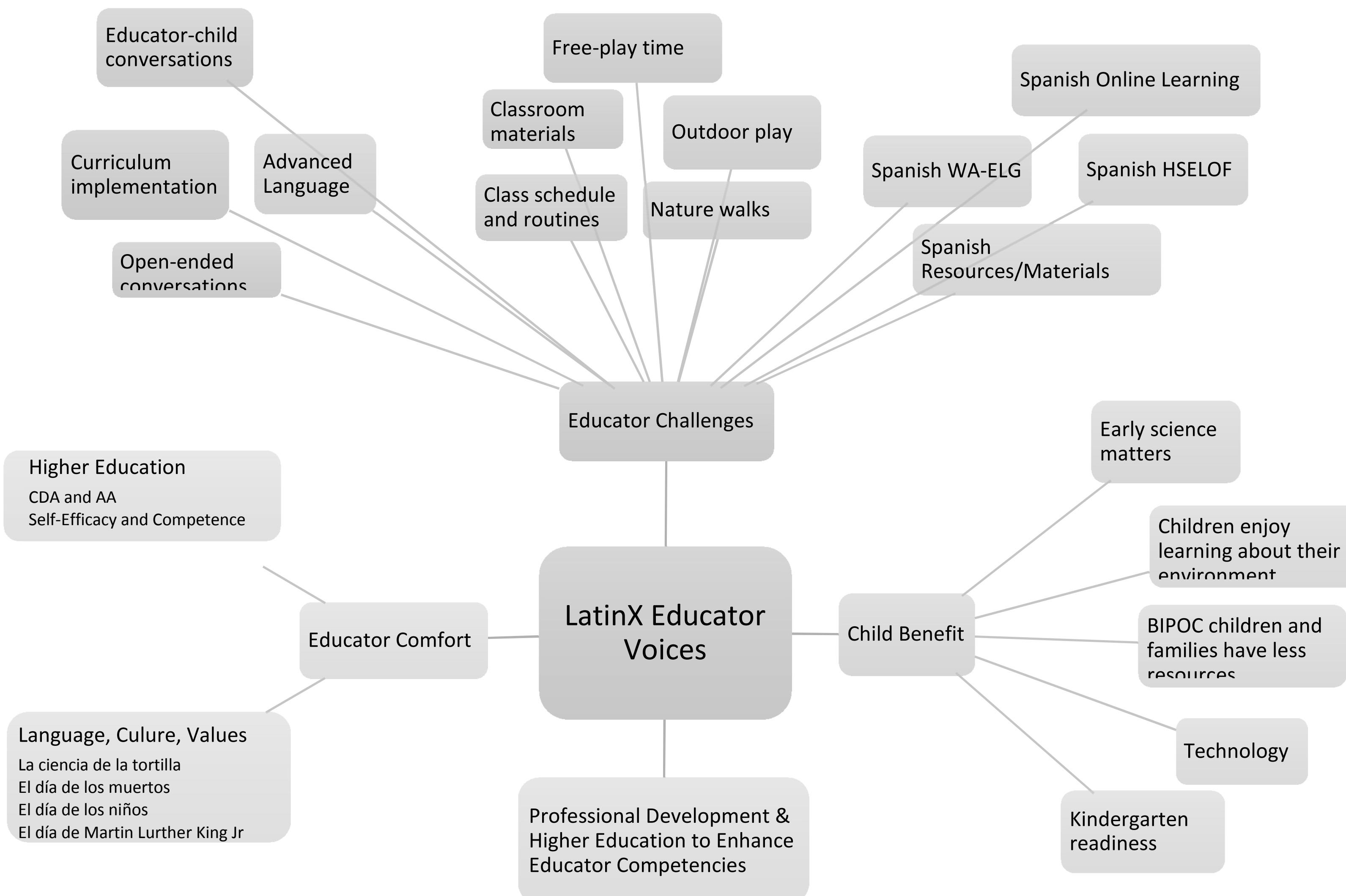


Figure 7. Evidence Regarding Early Science and the Voices of Seven LatinX Educators

4.3 Data Limitations and Implications

First, the current study is not without limitations. Because of my sample size, I cannot make causal claims, only associations. The data constrain the generalizability to similar settings to SPP programs. I could not verify if educator participation and program year match. The data also does not track educator turnover and educator mobility within SPP and SPP Pathway programs. Such checkpoints are essential to understand if continual coaching and professional development support educator practice.

Zaslow, Burchinal, Tarullo, and Martinez-Beck (2016) argue our knowledge of high-quality instruction is improving and involves "engaging activities, small and large group instruction, and sequenced presentation of instructional materials that allow for deep learning…". There is no single tool capturing all quality characteristics, but the researchers argue combining interaction-specific and domain-specific quality measures are necessary. To expand on this line of thinking, Burchinal, and Cryer (2003) claim "the global dimension of quality may be reflected in very different types of practices that reflect cultural differences." While these results are promising, the data excluded set families and children from their secondary data analysis if "the primary language spoken at home was [not] English." In addition, the researchers' data limitations and considerations resulted in a varying spectrum of representation across three ethnic groups: European-American (68%), African-American (15%), Hispanics (6%), and the rest represents other ethnic backgrounds (11%). And yet, Head Start, which serves primarily low-income children and their families, has estimated that approximately 30% of their enrollees identify as ELLs (Office of Head Start, 2014); in other words, English is not their home language. In short, there is a large subset of the population, and their values of quality are yet to be included. The demographics of the sample population to validate an assessment matter because this data identifies and guides professional development for educators.

Second, educators' voices emphasize how critical assessment tools are to progress by validating such tools across time, settings, and diverse populations. Equally important is institutional schooling, from early childhood education to college and beyond, to explore their preparation and skill set to support children and families furthest away from race and social justice. In this study, findings are limited to my participants' demographics, living in a city, and lived experiences with schooling, professional, and personal. Nevertheless, one can relate with educators' voices – which only strengthens the generalizability of their stories.

For example, the total population of the NICHD SECYD in 1991 is not representative of changes in time and context. Benchmarks are checkpoints evaluating success; however, when CLASS® has yet to enhance the assessment to value cultural wealth as knowledge or sense-making practices and identify educator bias, certain groups of children risk unintended consequences for those most in need. A shortcoming is that the findings represent children with parents from white, upper-middle-class, educated, and two-parent households. Second, the CLASS® assessment centers on a global child's experience or the average child's experiences. However, not knowing an individual's child's experience is problematic because we miss essential experiences, especially from big black boys who exhibit challenging behaviors from the educator's perspective. Finally, the generalizability and implementation limitations are most harmful to nondominant children and families. *Why do child, educator, and family demographics matter?* An analysis of seven major studies in ECE indicates no convincing evidence of an "association between teachers' education or major and either classroom quality or children's academic gains" (Early, 2007). Studies have yet to explore the educator race link to classroom quality or children's academic gains. Family socioeconomic advantages are a driving force behind children's exposure to cognitive stimulation in their learning (Crosnoe, Levental, Wirth, Pierce, & Pianta 2010). Further analysis of the NICHD study on the achievement of low-income children indicates "a substantial race gap present by three years of age and that both family and school characteristics were related to the development, maintenance, and perhaps widening of this racial achievement gap" (Burchinal, Steingber, Friedman, Pianta, McCartney, Crosnoe, & McLoyd, 2011). Hence the CLASS® should (1) address every child, not just the average child, (2) address inequities in teaching – where observers know what to do when they see acts of racism or other inequalities, (3) address representation (manuals, training videos, etc.), and address bias (observers).

We are at a crossroads; I think it essential to identify and de-settle structures, such as the foundational theoretical frameworks mobilizing QRIS and their components (i.e., standards/guidelines, curriculums, assessment tools, and quality improvements). This checkpoint must be a part of a model for any possibility of broadening equity within quality education (Haraway, 2016). Models could leverage multiple modalities, concepts do work-for and work with nondominant communities. For example, Indigenous communities of México leverage their skills to learn by observing ongoing events in collaborative efforts (Silva, Correa-Chávez, & Rogoff, 2010; Barajas-López & Bang, 2018). This form of knowledge building needs to be part of children's everyday learning experience. Otherwise, what work is this model doing if assessments and quality improvements are not supporting LatinX educators from their experiences?

Chapter 5. Discussions and Conclusion

Early child education investments are successful when families and educators of infants, toddlers, and preschoolers are supported and connected to resources guiding children's development and preparation for kindergarten and beyond. To this end, to make progress, WE need to problematize what is known and not known about child development and learning and the social and cultural contexts in which children and families live and make sense of the world around them (e.g., Cheng, 2001; Cheuck and Hatch, 2007). It is important to note that the white-privileged empiricist perspective describes quality. Racial, ethnic, and gender dynamics between students and educators influence educator perception of students (Dee, 2005). Nondominant educator's "wealth of knowledge" (Yosso, 2005), other ways of being and engaging with the world (Cochran, Huntington, Pungowiyi, Tom, Hungtinton, Maynard, & Trainor, 2013), problematizing what is a **f**act (McDermott & Webber, 1998; Cajete, 2000, Bang, Warren, Rosebery, & Medin, 2012; Eberbach & Crowley, 2009; Metz, 1995) are nuances yet to be explored while problematizing and rethinking futures of science education. Hence, in this study, I argue a need to think beyond the status quo when rethinking professional development for early childhood educators. For continuous quality improvement efforts to be effective, research and practice need to address *the who, what, how, and the call to action.* I situate science education change drivers at the center of Federal, State, and local quality standards assessment.

5.1 Discussion

To review, the objective for quality classroom assessments remains how closely does quality align to children's outcomes, how to evaluate children's outcomes, how stable classroom quality is across the school year, and how reliable data collectors must be for observation to link to children's growth (Early, Sideris, Neitzel, Laforett, & Nehler, 2018). In addition, the National

Association for the Education of Young Children (2012) recognizes educator quality, including content knowledge and practice skills, are the cornerstone of providing a child with positive interactions and enrichment experience enhancing their learning. We know institutional systems place nondominant communities' epistemic practices outside meaningful learning (e.g., clay work, fishing, farming, weaving, cooking, making perfumes) (Stromholt & Bell, 2017). For example, in exploring classroom experience: bias and equity, through eye-tracking devices, researchers are tracking educators' attention across gender (boy and girl) and race (white and black) when asked to identify when a "behavioral problem" is likely to occur.

5.1.1 Science in LatinX Led Classrooms

I first asked what early science teaching looks like in LatinX led classrooms in the 2018-2019 Seattle Preschool Program? Unfortunately, the findings indicate more than half of the children in the 2018-2019 SPP in LatinX led classrooms do not experience high-quality learning opportunities. The problem of uneven exposure has been reported in other studies examining high-quality instruction in pre-K (Pianta, Belsky, Houts, Morrison, & NICHD ECCRN, 2006; Goodvin & Rashid, 2020). Given these findings, the reality of young children's experiences is far from the goal of providing all children with high-quality opportunities.

First, ECERS-3 Item 22 Nature/science 100% of LatinX led classrooms were found to have at least 5 developmentally appropriate nature/science materials from at least 2 categories accessible during the observation for at least 25 minutes. Over 85% found staff talks about nature/science with the children during the observation. 50% were found to have a sand or water table with appropriate toys and are accessible for at least 25 minutes during the observation. Only 25% of LatinX educator led classrooms were found to have at least 15 nature/science materials, seen from each of the 5 listed categories, accessible in a clearly defined nature/science interest center for at least 1 hour during the observation. Finally, about 10% of LatinX classrooms had staff initiate activities for measuring, comparing, or sorting using nature/science materials. Early, Neitzel, LaForett, and Nehler (2018) show a mean = 2.54, SD = 1.17, and N=1063 (where 4.4% were LatinX educator led classrooms) for Item 22 Nature/science whereas this study shows a mean = 3.22, SD = 1.72, and N = 9. Most Quality Rating and Improvement Systems (QRIS), including Early Achievers, use professional development, coaching, and training for quality improvement. One strategy to support best practices for nature/science could be to have continuous quality improvement efforts to focus on nature/science amount of materials in the classroom, how long they are accessible, and how to engage in nature/science play with children.

Next, we know CLASS® is a reliable way to capture the quality of education child conversations (Downer, López, Grimm, Hamagami, Pianta, & Howes, 2012; Barnes-Najor, Thompson, Cameron, Smith, Calac Verdugo, Brown, & Sarche, 2021). We also know that a child's assignment to an own-race educator increases black and white students' achievement (Dee, 2004; Vincent, Tobin, Van Ryzin, 2017). Research also shows children from nondominant communities have varied repertoires of practices not in place in institutions (Silva, Correa-Chavez, & Rogoff, 2010; Rogoff, 2014). However, minimal to no research has been done to intentionally explore the nuances of educator race and CLASS® (Downer, López, Grimm, Hamagami, Pianta, & Howes, 2012; Barnes-Najor, Thompson, Cameron, Smith, Calac Verdugo, Brown, & Sarche, 2021; Dee, 2004; Vincent, Tobin, & Van Ryzin, 2017). Only 33% of LatinX led classrooms met a 3.0 IS threshold, and 0.11% scored at, or less than 1.50 IS.

Moreover, in LatinX educator led classrooms (N=9), a mean of 2.51 and an SD of 0.65. The NIEER's year four (2018-2019) SPP and SPP Pathway impact evaluation study shows a mean of 3.18 (N=73) and an SD of 0.85. In other words, LatinX led classrooms are scoring less half a point when comparing the mean and the IS threshold of 3.0. Findings indicate an uneven exposure of quality in LatinX led classrooms. The problem of uneven exposure has been reported in other studies examining high-quality instruction in pre-K (Pianta, Belsky, Houts, Morrison, & NICHD ECCRN, 2006; Goodvin & Rashid, 2020).

5.1.2 LatinX Educators Teaching Science and Lived Experiences

The second question I asked is how LatinX educators understand and discuss their science teaching? Research shows various challenges influence educators' behavior, impacting the frequency, quality, and instruction content across cognitive domains (Wilkins, 2008). Educator "low-self-efficacy in science and time management issues are two possible barriers for why preschool educators may have difficulty teaching science" (Greenfield et al., 2009; Tu, 2006; Tu & Hsiao, 2008). Educators ask for continual support using science materials (Nayfeld, Brenneman, & Gelman, 2011; Maier, Greenfield, & Bulotsky-Shearer, 2013; Pintó, 2005). Educators believe LatinX children do not want to get dirty. I can only offer my personal experience as an explanation. As a child of immigrant farm-workers, my family was faced with choosing by having the security of a home, the comfort of food, or clothing. At the age of 5, I was taught to be responsible for my clothing to avoid the consequences. I wonder if these families are also experiencing financial hardship where children's pretend play is affected (Patterson, 1986; Puff & Renk; 2014).

First, unfortunately, this study identifies professional development as variable and inconsistent in changing teaching and learning practices (Pintó, 2005). Rethinking the futures of science involves making connections across multiple contexts – the natural, physical, and social worlds (Windschitl, Thompson, & Braaten, 2008; Nasir & Hand 2006; Campbell, Schwarz, &

Windschitl, 2016; Bricker & Bell, 2014). We must situate science in context and history, where places and artifacts represent local and worldwide community epistemic practices (Zimmerman & Bell, 2014). The findings are similar to Tu & Hsiao (2008), where educators felt science is: (1) hands-on opportunities are essential, (2) using their five sense, (3) asking questions, predicting outcomes to see what happens, and (4) exploring, experimenting, thinking, and discussing. The goal is to create a thriving community of learners who are "united in a shared experience of trying to make meaning of their lived experience" (Elias, 1997). LatinX educators describe not knowing what they are doing counts as science. Educators do not see what children are doing (e.g., making tortillas, making their perfumes, clay work) count as science (Stromholt & Bell, 2017; Yosso, 2005; Edwards & Loveridge, 2011). Drawing from this research, we also know negative early science experiences negatively influence their engagement with science education. LatinX educators are just as likely to connect social studies into their day-to-day conversation with children (Tu & Hsiao, 2008). I would argue LatinX educators reflect JEDI principles in connecting values, culture, and history to teaching and learning.

Second, we know guidelines are essential to assessing quality standards (Soderberg, Joseph, Stull, & Hassairi, 2016). Guidelines communicate with parents, educators, and stakeholders what we can expect children to learn. LatinX educators do not know WA-ELG or HSELOF is of great concern. We know there is no major study examining the consistency of standards between age cohorts and the extent to which two documents align to compare age groups, or the extent standards demonstrate a developmental progression (Scott-Little & Reid, 2010; Scott-Little, Kagan, Reid, Sumrall, & Fox, 2014; Kagan, Scott-Little, Reid, & Castillo, 2013). In tandem, Briseño, Joseph, Bang, and Sanders (2017) evaluate the extent to which the HSELOF compares with the current WA-ELG in characterizing science education benchmarks

(Greenfield et al., 2009). The research shows only the practice (Observe) was positively correlated with the count of science benchmarks (the outcome), indicating that the practice (Observe) is related to higher benchmark counts. The practice (Cooperate) was negatively correlated with the count of science benchmarks (the outcome), indicating that the Cooperate benchmark is absent. None of the other practices directly connect to benchmark counts. More interestingly, there was a significant direct relationship between guideline type and benchmark count. Thus, we can conclude LatinX educators miss out on connecting their lived experiences with federal and state guidelines.

Third, professional development is an accountability tool centering on educator competence, knowledge, and skills to enhance frequency, quality, and instruction content to achieve child gains (Snyder, Hemmeter, & McLaughlin, 2011; Zellman & Karoly, 2012; Wilkins, 2008). Our professional development efforts need to expand "when is science" as we consider the "interests of the children, parents, other educators, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives" (Edwards & Loveridge, 2011). In other words, young children and educators investigate the natural world from their interest and agency (Mitra & McCormick, 2017; Nasir & Hand, 2006; Nasir & Cooks, 2009). Finally, educators need professional development and training to be meaningful and intentional to enhance educator practice. Making progress in the design of transformative learning environments requires the intentional resourcing of (1) classroom materials, (2) sequence and delivery of professional development intervention, and (3) space to engage in reflective practices (McNerney, Nielsen, & Clay, 2006).

LatinX educators do not have ongoing communication with professional development, and 47% of participants report not engaging in science talk. To enhance educator teaching frequency, quality, and instruction content (Wilkins, 2008), both the coach and educator need the space and time to deconstruct notions of what, why, and when quality teaching is. They are unaware science is all around us, and it seems like their epistemic practices need to be acknowledged and valued by education systems. In other words, this group of educators may already be doing science and not realize the value of their teaching practices. Findings are similar to prior studies (i.e., Maier, Greenfield, & Bulotsky-Shearer's 2013; Tu & Hsiao 2008, Greenfield et al., 2009, etc.). Educators also have lower levels of discussion of "ideas and issues of science teaching," suggesting educators do not use other resources when teaching science – similarly to LatinX survey responses. In short, educators' responses emphasize an adequate level of comfort to teach science, agree teaching science early on is beneficial, but have difficulty embedding science along with the day-to-day care and education responsibilities.

Prior research (Pendergast, Liberman-Betz, & Vail, 2017) indicates 90% of educators enjoy teaching science weekly and integrated science in literacy activities, using multiple resources and felt preschool science fosters an interest later in life. It is essential to consider that 50% (110 respondings) had previously participated in professional development opportunities specific to science. Despite these opportunities, 82% (112 respondings) indicated an interest in continual professional development opportunities specific to science. It is important to note that 61% of participants were white, and 34% were African-American. Therefore, educators and learners need to experience scientific education from intentionally designed cohesive curriculum units instead of a series of unrelated and isolated lessons (Ambitious Science, 2018). Findings vary with prior research; where Tu and Hsiao (2008) show educators most preferred area to teach was Language and Literacy (45%), Health, Safety, and Nutrition (10%), Gross Motor and Outdoors (10%), Science (5%), and Social Studies (5%). A possible explanation could be that Tu and Hsiao (2008) participants were all white females. We also know cultural differences in children's attention, and perhaps nondominant educators' choices guiding educator-child conversation differ (Silvia, Correa-Chávez, & Rogoff, 2010; Nasir, Rosebery, Warren, & Lee, 2006).

To conclude, exploring assessment quality standards is crucial to ensure all children receive high-quality experiences. Professional development enhancements must address crosscutting concepts and practices (Edwards & Loveridge, 2011; Elek & Page, 2019). First, I argue that continuous quality improvement efforts need to situate knowledge from the learners' voices, interests, and values in transformative learning classrooms (Callison, 2014). Second, professional development needs to situate on observed educator and child interactions, educator and coach reflective back-and-forth feedback, and accountability to educator-coach specific goals and action planning. Especially when SPP and SPP Pathway programs are developed to enhance quality opportunities for JEDI and study shows enhancement for LatinX educators are needed. Race, equity, diversity, and inclusion matter because (1) the racial mismatch between children and educators (Heath, 1983; Nasir, Rosebery, Warren and Lee, 2006; Ceglowski, 2004; Burchinal and Cryer, 2003), (2) educator preparation for racially diverse contexts (Hardin, Lower, Smallwood, Chakravarthi, Linlin, & Jordan, 2010; Medin & Bang, 2014; Hardin, Lower, Smallwood, Chakravarthi, Linlin, and Jordan; 2010), and (3) racial inequities in school discipline (Yosso, 2005; Gilliam, Maupin, Reyes, Accavitti and Schic, 2016; Stipek, 2004).

5.1.3 Adaptations and Recommendations to Assessment Standards

To overview, researchers investigate multiple data sources to explore educators' understandings and discussion of early science teaching. It appears that these factors influence educators' regard to supporting children's scientific learning. However, while these researchers report educator demographics, fidelity to curriculum, professional development, teaching experience, gender, and the highest level of education, for the most part, investigations did not report how these factors relate to educators' understanding and discussion of early science teaching. See Table 4. Also, there is a pressing need for research efforts to explore the nuances of how educators fare in quality assessments by educator race/ethnicity (i.e., Early, Sideris, Neitzel, LaForett, & Nehler, 2018; Hindman & Wasik, 2013; Burchinal, Field, Lopez, Howes, & Pianta, 2021; Moiduddin, Aikens, Tarullo, West, & Xue; 2012). Finally, this study explores the intersectionality of how LatinX educator-led classrooms fare on quality assessment standards evaluating science (See Figures 1 and 2) and LatinX educators' understandings and discussions of early science.

The findings suggest adaptations need to be done with care, considering cultural issues and quality aspects based on research and proven experience in preschool (Garvis et al., 2017). Edwards and Loveridge (2017) suggest that "participants' knowledge bases increased in accordance with the interests of the children, parents, other teachers, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and global perspectives." Using quality data to contextualize the quantitative findings, followed by the literature review, it is essential for policy and practice to invest in continuous quality improvement and continuing efforts to enhance quality assessment standards from nondominant epistemic practices. First, findings suggest that continuous quality improvement needs to be intentional and purposeful to LatinX educators' lived experiences and for their counterparts to learn to be aware and responsive to nondominant children's knowledge funds. Therefore Tables 12 and 13 below make addendum recommendations. It is important to emphasize that observers (users of the tools) need to broaden and deepen their understanding contextualized to quality local and global perspectives. The aim is to develop a tool that can be adaptive and flexible to communities' knowledge, values, and beliefs while facilitating essential skills for learning and development. See Section 1.3 Evidence Regarding Assessment Quality Standards.

Table 12: ECERS-3 Item 22 Nature/science Addendum Recommendations

ECERS-3 Item 22 Nature/science _Indicator Level	Addendum
1.1 No nature/science materials accessible	
1.2 Staff do not talk about nature/science with the children during the observation (Ex: mention weather, seasons; read a factual book on animals; mention water temperature).	Ex: cooking tortillas, celebrations, customs, history, values, language
1.3 Staff show a lack of interest or dislike for the natural world (Ex: show fear of a large spider instead of cautious respect; ignore natural occurrences).	Ex: lack interest in recycling and respecting our plant and animal relatives
3.1 At least 5 developmentally appropriate nature/science materials from at least 2 categories are accessible for at least 25 minutes during the observation.	Ex: tortilla maker, molcajete, nature
3.2 Staff talk about nature/science with the children during the observation (Ex: do weather chart; ask names of animals in pictures; talk about healthful food as a snack).	Ex: link language, values, history to the science activity through conversation; talk about local and global resources and perspectives
3.3 Sand or water, with appropriate toys, is accessible for at least 25 minutes during the observation.	Ex: children engaging with soil and investigating the ecosystem as an additional pathway
5.1 At least 15 nature/science materials, some from each of the 5 listed categories, are accessible in a clearly defined nature science interest center for at least 1 hour during the observation.	Ex: tortilla maker, molcajete, nature
5.2 Staff use and talk about nature/science materials with the children.	Ex: expand the definition of materials/tools to include everyday indoor and outdoor experiences
5.3 Staff model concern for the environment (Ex: remind children to turn off the water or turn off light to save resources; recycle; discuss how insects can be helpful).	Ex: link to child's home knowledge and extend on language/s, values, history to the science activity through conversation; talk about local and global resources and perspectives
7.1 Staff initiate activities for measuring, comparing, or sorting using nature/science materials (Ex: show children how to sort seashells by color, shape, or size; arrange pinecones from biggest to smallest; chart rainfall for a month to discuss dry and wet times; predict weights of various natural objects).	Ex: outdoor dirt play, making tortillas, pretend play, contextualized to the communities environment and open to local and global perspectives
7.2 One or more pets/plants present that children can easily observe, help care for, and that are talked about with the children (Ex: classroom fish tank, hamster, gerbil; birds that are seen visiting filled bird feeder).	Ex: educators talk about the importance of pets/plants to our ecosystem and discuss knowledge and values from multiple perspectives

Table 13: PreK CLASS - Instructional Support Addendum Recommendations

Domain	Dimension	Description	Addendum
Instructional Support (IS)	Concept Development	Measures the teacher's use of instructional discussions and activities to promote students' higher-order thinking skills and cognition and the teacher's	When data collectors observe, they should be aware and responsive to cultural differences by knowing about the community to determine when it is

		focus on understanding rather than on rote instruction	appropriate to code. For example, making tortillas can be an example of building on a child's lived experiences and prior knowledge. Knowing an educator's prior knowledge is fundamental for continuous quality improvement to effectively build educator practices from their sense making repertoires.
	Quality of Feedback	Assesses the degree to which the teacher provides feedback that expands learning and understanding and encourages continued participation.	
	Language Modeling	Captures the effectiveness and amount of teacher's use of language stimulation and language-facilitation techniques.	

5.2 Calls to Action: Rethinking Early Science Education

WE need to acknowledge early science education is an activity socially and historically conditioned from white empiricist perspectives (Cajete, 2000; NRC, 2012). First and foremost, a learner's experience MUST be the foundation (Mitra & McCormick, 2017). Second, I argue the possible futures of science education need to be locally contextualized, relevant to the child, and open to local and global perspectives. Finally, coaching, training, and professional development enhancements MUST be intentional and meaningful to meet educators where they are at, focusing on anti-racists practices.

WE need teaching practices where children can explore, experiment, discover, and solve problems in imaginative and playful ways—enabling children to engage in self-directed play internally motivated – where the educator is discussing, embedding, and extending the learning with children. Various challenges influence educators' behavior, impacting instruction frequency, quality, and content across cognitive domains (Wilkins, 2008). For example, from the extensive literature review of preschool science education, educators have various teaching competencies to facilitate science play. Yet, educators teach rigid, prescriptive, and lead instruction through listening instead of self-directed play and imagination. Practical implications for early childhood education are to build educator practices (Merino et al., 2013). For example, (1) create a classroom environment representing diverse interest areas offering rich play opportunities, and (2) draw on young children's home knowledge and lived experiences.

WE need to acknowledge educators bring their conceptions of *what, how, when, and who does* science. Educators' past and present experiences influence the types of learning activities they design for young learners. Drawing from literature, educators feel underprepared to teach early science content and process. Educators believe their negative early science education experiences influence their science teaching practices and negatively impact a child's scientific identity (Tu & Hsiao, 2008). Educators identify their negative schooling experience and learning as the primary source of their discomfort. The aim is to counter-historical and current white-privileged empiricist perspectives rooted in oppression, continuing to place the nondominant community's "wealth" outside meaningful learning (Yosso, 2005). We need rigorous, intentional, and meaningful workforce talent enhancements for educators from nondominant backgrounds to succeed. Likewise, white educators in public institutions require the time and space to work through anti-BIPOC biases to support children and families of color. The need to embed crosscutting concepts with lived experiences is essential. When people face a historical and current mismatch between the school's culture and their cultural backgrounds, stakeholders and policymakers cannot set trauma and shock to the side of quality and interventions (Bang, Warren, Rosebery, & Medin, 2012, Bang & Medin, 2010; Paris & Alim, 2014).

5.3 Conclusion

Unfortunately, the findings from this study indicate more than half of the children in the 2018-2019 SPP in LatinX led classrooms do not experience high-quality learning opportunities. The problem of uneven exposure has been reported in other studies examining high-quality instruction in pre-K (Pianta, Belsky, Houts, Morrison, & NICHD ECCRN, 2006; Goodvin & Rashid, 2020). These findings raise four critical issues for early childhood education research, practice, and policymakers: First, how can quality assessment tools be enhanced to achieve a global definition of quality representing different practices from different cultural experiences? Second, how can educators be prepared to enhance their competencies and talent to provide consistently high levels of quality positively influencing children's social and academic development? Third, professional development, training, and coaching must be culturally relevant and move beyond the status quo. In other words, educators need support to enhance their confidence and practices, especially related to instructional support. Fourth, how can nondominant communities be generators of knowledge across QRIS models?

Second, listening to LatinX educators' science teaching related to their lived experiences indicates that educator comfort, educator challenges, and child benefit are essential components to enhance educator competencies. LatinX educators do not see their cultural experiences connected with facilitating emergent scientific reasoning in preschool children. Perhaps, most perplexing is that educators mention achieving higher academic degrees, helping them connect their experiences with science inquiry. It is almost as if their cultural background and experiences need to be valued and acknowledged by institutionalized systems. Or LatinX educators are unaware of what, when, and who does science, and they need help to connect the relationship of their experiences with science education. LatinX educators describe a need to relate language, values, history, and social justice to educator-child conversations to science education. Another concern is that children of color do not want to get dirty or engage with the environment more than white children. Another pressing concern is the pre-K to Kindergarten divide; educators believe they need to connect to what Kindergarten educators want - not situated on child learning and development.

These findings raise two critical issues for the early childhood education research, practice, and policy: First, how can the early childhood education system enhance LatinX confidence and competency with science education, pre-service, and in-service. Second, LatinX educators require professional development to be culturally sustaining and increase their competence with educator-child conversations (Elek & Page, 2019; Couse, & Recchia 2015).

I note in closing that this study contributes to our understanding of early science education, educator preparedness, and classroom quality from *la voz* of LatinX educators. First, young children make sense of the social, natural, and physical worlds in meaningful and sophisticated ways before entering kindergarten (Cajete, 2000; NRC, 2012). Second, a transformative learning environment creates education systems, cultivating just, sustainable, and thriving communities - "united in a shared experience of trying to make meaning of their lived experience" (Elias, 1997). Next, discourse situated on making progress involves exploring beliefs, feelings, and values (Cranton, 2006) from the perspectives of nondominant communities. Fourth, educators need the time and space to observe their practice, reflect on it, and receive individualized feedback on what is working and what needs further development. Finally, to make progress, assessments and professional development must be locally contextualized, relevant to the child, and open to both local and global perspectives (e.g., Cajete, 2000, Bang, Warren, Rosebery & Medin, 2012; Banks, 2007; Stromholt & Bell, 2017; Zimmerman & Bell, 2014).

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Appendix A: Educator Survey and Educator Thinking Group Protocol

Survey Draft Proposal

My name is Luis Miguel Briseño Sandoval; I am working on my doctorate studies. I currently live in Seattle; I am a Professional Development Specialist Team Lead for Cultivate Learning. I am a graduate of the University of Washington with my Master's in Educational Psychology, and I have my Bachelor of Science in Bioengineering. Before that adventure, I taught an infant, toddler, and preschool classroom for two years. As you can see, I am rooted in child development and passionate about young children receiving quality care and education. I want to extend a thank you for completing this questionnaire. This study will help to understand how to better support educators to engage in scientific education. As our understanding of science's nature in classrooms continues to develop, we must learn more about educators' perspectives and beliefs to use professional development training and resources.

***These questions may already be answered by demographic information collected already.**

1. What age group do you currently teach?
    - Infants (Birth – 11 months)
    - Toddlers (12 months – 3 years old)
    - Pre-k (3 years old – before entering Kindergarten)
    - Family Child Care (mixed-age groups)

2. How many years have you worked teaching preschoolers?
    - 0 – 5 years
    - 6 – 10 years
    - 11 – 15 years
    - 20 or more years

3. To what organization do you belong?
    - For-profit child care
    - Not for profit childcare
    - Faith-affiliated
    - Head Start
    - Early Head Start
    - ECEAP
    - Center-based child care
    - Family child care
    - Other

4. In what language/s do you speak most fluently?
    - English
    - Spanish
    - Vietnamese
    - Chinese

- ☐ Somali
- ☐ Oromiffa
- ☐ Other

5. What is your gender?
   - ☐ Male
   - ☐ Female

6. What is your racial background?
   - ☐ White/Caucasian
   - ☐ Black/African-American
   - ☐ Asian
   - ☐ American Indian or Alaska Native
   - ☐ Native Hawaiian or other Pacific Islander
   - ☐ Other, specify: ____________
   - ☐ Unknown

7. What is your highest education level?
   - ☐ High School/GED
   - ☐ Associates (AA)
   - ☐ Child Development Associate (CDA)
   - ☐ BA or BS.
   - ☐ MA.
   - ☐ Ph.D.

8. In what part of Washington State is your program?
   - ☐ Olympic Peninsula (Clallam, Jefferson, Grays Harbor, Mason, Kitsap, Thurston Counties)
   - ☐ Northwest (Whatcom, Skagit, Snohomish Counties)
   - ☐ King County
   - ☐ Tacoma or Pierce Counties
   - ☐ Southwest (Pacific, Lewis, Cowlitz, Clark, Skamania, Klickitat Counties)
   - ☐ Central (Okanogan, Ferry, Chelan, Douglas, Grant, Kittitas, Yakima Counties)
   - ☐ Eastern Washington (Stevens, Lincoln, Spokane, Pend Oreille, Whitman, Franklin, Walla Walla, Columbia, Garfield, Asotin Counties)

9. How many Early Achievers Institutes have you attended?
   - ☐ None
   - ☐ At least 5 times
   - ☐ At least 10 times
   - ☐ At least 15 times

10. In the past two years, how many professional development opportunities specific to science have you attended?

- None
- At least 1 - 2
- At least 3 - 4
- At least 5 - 6
- At least 7 or more

11. Do you need professional development opportunities specific to science?
    - Yes
    - No

12. Please select the activities that involve you making or building new things related to the natural world?
    - Child-related display
    - Furnishing for relaxation
    - Meals/snacks
    - Books and Pictures
    - Fine Motor
    - Art
    - Blocks
    - Sensory (Sand/Water)
    - Dramatic play
    - Nature/science
    - Math/number
    - Computer
    - Language and literacy
    - Outdoors
    - Promoting Acceptance for Culture and Diversity

13. How many hours a week does your coach support you?
    - 0 - 2 hours
    - 3 - 4 hours
    - 4 - 6 hours
    - 6 - 8 hours
    - 8 or more hours

14. How many of those hours are specific to your science teaching?
    - 0 - 2 hours
    - 3 - 4 hours
    - 4 - 6 hours
    - 6 - 8 hours
    - 8 or more hours

Thinking Group Activities

Part I. Exploring beliefs and approaches to teaching (science)
Directions: Ask participants to think-pair-share about sayings/phrases/stories relating to their teaching and learning cultural values.

Step 1: Individually

1. Think of a saying/phrase/story from your culture capturing an essential aspect of your teaching and learning approach in your classroom?

Step 2: Group Share Aloud

1. Why is this saying/phrase/story important to you?
2. How does it relate to your teaching and learning?

Part II. Exploring what happens throughout the day of a child in a classroom
Directions: Participants will reflect on the following questions individually.

What happens on a child's day during your care and education?

1. Can you describe what happens on a child's day during your care and education?
2. What *open-ended materials/activities* do you engage with children to figure things out?
3. What *open-ended materials/activities* involve children making or building new things?
4. How do you decide what *open-ended materials/activities* are open to children?
5. How long does a child have access to *open-ended materials/activities*?
6. How do you engage with children during *open-ended materials/activities?*
7. Do you go outdoors? How long during the day? How many times a week?
8. Can you describe what happens outdoors?
9. Do you think it's important for children to be outdoors?

Note: O*pen-ended materials/activities are those in which children can use materials appropriately in their way, with an outcome that is not predetermined by the staff or the material itself.*

Part III: Images of the world around us.
Directions: As a whole group, discuss the following questions.

Do educators refer to resources to develop a child's problem-solving and discovery skills?

1. What skills are important for a child's learning and development?
2. Do you engage in activities requiring more input from you?
    a. If so, for how long and why do you think this is important?
    b. If not, why not?
3. Do you use the HSELOF to support your teaching and learning of child objectives?
4. Do you use the WA-ELG to support your teaching and learning of child objectives?
5. Do you use a curriculum to support your teaching and learning of child objectives?
6. How do you use these resources? Why?

Part IV: Knowledge, Value, Belief, and Concern

Directions: Participants will reflect on the following questions individually

Do educators think knowledge, value, or belief are important to teach science?

1. From your perspective, what knowledge is important to teach science?
2. From your perspective, how are values important to teach science?
3. From your perspective, are beliefs important to teach science?

Do educators have concerns about teaching science?

1. Is it important to teach science in early childhood education?
2. What concern do you have about teaching science to children in your care?
3. What kind of professional development and training do you need to be successful?

Reflection: In the end, please share the following statement and ask about their opinions about practices.

Children engage and do science by exploring their surroundings, talking about the causes and consequences of the phenomena they observe, and their lived experiences with varied exposures to activities (e.g., clay work, fishing, farming, weaving, computing) relating to different science and engineering domains (NRC, 2012, Stromholt & Bell, 2017). An extensive literature review of standards and curricula, a national review of the content and process of 29 early learning standards for science learning, and ten preschool curricula identified eight essential process skills: observing, describing, comparing, questioning, predicting, experimenting, reflecting, and cooperating. These skills emerged from three broad content areas: Life Sciences (42% of all entries), Earth/Space Sciences (27%), and Physical/Energy Sciences (31%) Greenfield et al., 2009).

Appendix B: Evidence Regarding ECERS-3 and PreK CLASS

Reference/ Citation	ECERS-3/ PreK CLASS Used	Population/Participants (s)	Study Findings
Hestenes, Rucker, Wang, Mims, Hestenes, & Cassidy (2019)	ECERS-3	105 preschool classrooms: 50 five-star (48%), 40 four-star (38%), and 15 three-star (14%) 1,277 children: 100 were dual language learners, 581 received child care subsidy, 475 African American, 655 Caucasians, 133 Hispanics, 34 Asians, two Native Americans, and 78 children classified as other or multiple races/ethnicities. Educator race not reported	Scale / Without an Associate's Degree / Associate's Degree and Above ECERS-R / 5.37 (0.40) / 5.46 (0.52) ECERS-3 / 3.83 (0.50) / 4.22 (0.57) Scale / Five Stars / Four Stars / Three Stars ECERS-R / 5.62 (0.43) / 5.32 (0.53) / 5.23 (0.54) ECERS-3 / 4.34 (0.54) / 4.12 (0.55) / 3.88 (0.60) ECER-3 Item 22 Nature/science (n=105, M=3.21, SD=1.19, Min=1, Max 7) Six lowest scoring items on the ECERS-3 were related to requirements for teacher–child interactions that must be observed related to the use of specific types of learning materials or practices
Garvis, Sheridan, Williams & Mellgren (2017)	ECERS-R ECERS-3	153 Swedish preschool classrooms reflection of ECERS-3 no demographic data is reported	Reflection 1 on physical environment and room organization: Outdoor play is meant for children to play as is and not be too organized. Supervision is various as older preschoolers are allowed to have a more self-directed play, Use of snow as a play item reduced children's interest in playing with the equipment, Temperature at or below freezing levels prevent the use of outdoor equipment and outdoor sand, Sand/water play is considered an outside activity Reflection 2 Interaction and supervision: Multiple rooms in use and no legal requirement for continuous supervision of child play, educator-child interaction varies and is more child-led, the understanding of these concepts differ Reflection 3 Learning activities and language development: music experiences are focused on vocal and rhythmic development, access to musical instruments is limited, book reading occurs just not during the observation time, the restriction of the three hour observation time is problematic, Nature/science scored low even though the curriculum makes strong connections with nature and the environment. Adaptation needs to be with care, considering cultural issues and quality aspects based on research and proven experience in preschool.

Early, Sideris, Neitzel, LaForett, & Nehler (2018)	ECERS-3 Prek CLASS	ECERS-3 only Georgia (n=291), Pennsylvania (n=390), and Washington (n=263) PreK CLASS (n=119) Child assessments were done Lead teacher race/ethnicity (n=1063): Asian 2.35%, Black/African American 17.40%, Hispanic/Latino 4.33%, White 69.24%, Mixed race/Other 3.20%, Missing/refused 3.48% Child race/ethinicty(n=575): Blak/African American 16.55%, Latino/Hispanic 7.39%, White/Caucasian 56.51%, Mulitple 16.55%	CLASS Pre-K Instructional Support (n=118, M=2.26, SD=0.69, Min=1.00, Max=5.06) ECERS-3 Item 22 Nature/science (n=1063, M=2.54, SD= 1.17) ECERS-3 Learning Opportunities and Teacher Interactions were significant to predicting Instructional Support (p<.001) The ECERS-3 subscale most strongly associated with CLASS Pre-K was Teacher Interactions, which provides evidence for convergent validity since CLASS Pre-K is intended to measure teacher–child interactions (Pianta et al., 2008). Limitation: Findings indicate limited association with growth across all children; the links may be more robust for some children than others or under certain circumstances than others. Future analyses will investigate various moderators such as family income, race, and announced versus unannounced visits to address this possibility.
Peisner-Feinberg, Garwood, & Mokrova (2015)	ECERS-3 Prek CLASS	Programs/classrooms: n=102 preK classrooms Children n=595 including a subsample of 133 Spanish-speaking dual language learners Child race/ethnicity: 45% White, 36% African American, 8% Native American/Alaskan Native, 8% Multiracial, 2% Asian, 1% Native Hawaiian/Pacific Islander; and more than one-quarter (27%) of these children were of Latino ethnicity. No educator demographics are reported Child assessments were done	Child Outcomes: -Children in the NC Pre-K Program exhibited significant gains during their pre-k year across all learning domains. -Children with different levels of language proficiency and DLLs showed different rates of gain during participation in NC Pre-K for a few skills, but similar rates of growth for most. -Classroom quality generally was not related to children’s gains during the NC Pre-K Program. Classroom Quality: -The quality of NC Pre-K classrooms in the 2014–2015 sample was in the medium to a good range overall, across many different aspects of classroom practices. -The average level and overall pattern of classroom quality for the NC Pre-K Program have remained similar over time, although there have been some slight changes in the scores. -Stronger teacher beliefs in developmentally appropriate practices were the most consistent predictor of higher quality observed classroom practices. ECERS-3 Item 22 Nature/science (n=102, M=3.0, SD=1.0, min=1.0, max=6.0) Prek CLASS IS (n=102, M=2.6, SD=0.9, min=1.0, max=4.7)

Infurna, Embt, Hightower, Wagner, Strano, Lotyzweski, Montes, Macgowan, Hooper, Boyle, Lubecki, Peelle, Perez, Iadarola, & Townsend (2019)	ECERS-3 Prek CLASS	North Carolina ECERS-3 n=184 PreK CLASS n=186 Child race/ethnicity (n=1771): Black/African American 53.9%, White Caucasian 9.7%, Hispanic/Latino 31.1%, Asian 4.2%, Native American 0.7%, Other 0.2% No educator demographics are reported	On average, the aggregate ECERS-3 performance in 2018-19 remained relatively consistent with the 2017-18 year. This past year, the ECERS-3 total score increased slightly from the last year's 5.3 to a mean score of 5.4. The Instructional Support domain dropped slightly from 4.4 to 4.3.
Burchinal, Garber, Foster, Bratsch-Hines, Franco & Peisner-Feinberg (2021)	PreK CLASS	Rochester, New York Pre-k classrooms n=63 Child race/ethnicity n=362: African American/Hispanic 3%, African American/nonHispanic 33%, White/Hispanic 33%, White/nonHispanic 28%, Other, 11% Child assessments were done Educator demographics were not reported	PreK CLASS IS (n=62, M=2.66, SD=0.66) This study indicated that children showed gains in language skills when they experienced more frequent complex language exchanges with their teacher, spent more time in literacy activities, and spent less time in whole group activities. Results indicate that the acquisition of receptive language skills in ECE may be promoted by frequent complex language exchanges between the teacher and the target child. Classroom-level ratings of teacher-child interactions currently dominate how quality is defined, programs are evaluated, and professional development is designed to improve quality (Burchinal et al., 2015)
Moiduddin, Aikens, Tarullo, West, & Xue (2012)	PreK CLASS	Child race/ethnicity n= 3022: Hispanic/Latino 36%, African/American 34%, Caucasian 22% Child assessments were conducted Spanish is the most prevalent non-English language and is the primary language spoken to 24 percent of children at home. Educator race/ethnicity: White 42%, African/American 31%, Hispanic/Latino 22%	FACES measured teacher beliefs and attitudes using a 24-item Teacher Beliefs Scale (Burts et al. 1990) that consists of statements worded to reflect positive attitudes and knowledge of generally accepted practices in preschool settings or reflect a lack of such attitudes and knowledge. Depressive Symptoms Among Head Start Teachers: Spring 2010 - 4% Severely depressed, 7%, moderately depressed, 22% are mildly depressed, 67% are not depressed PreK CLASS IS: (M=2.3) & CLASS Instructional Support Threshold 2.75 Higher levels of Instructional Support as measured by CLASS were associated with increased academic and language skills in preschoolers.

Hindman & Wasik (2013)	PreK CLASS	Child race/ethnicity: Black 33%, Hispanic/Latino 36%, Other backgrounds 3%, White 22%, Multiple backgrounds 5% Teacher race/ethnicity: Black 37%, Hispanic/Latino 20%, Other background 22%, White 42% Educators n=293, Head Start centers n=116, children n=2501 Child assessments were done	The CLASS domain of Instructional Support was positively correlated with children's Spanish and English vocabulary. Spanish language use and emotionally supportive interactions as measured by CLASS were associated with improved approaches to learning. 22% of teachers reported receiving no mentoring, 17% received mentoring less than once per month, 24% received mentoring once per month, 8% received mentoring once every two weeks, and 29% received mentoring once per week. 31% of teachers attended at least one training and technical assistance session during the year. Children of minority ethnicities (Black and other groups) had slower growth in vocabulary skills Teachers' reports of receiving mentoring and training and technical assistance positively predicted the reported frequency of their vocabulary instruction PreK CLASS IS (M=1.92, SD=0.55, min=1.00, max=4.11)
Burchinal, Field, Lopez, Howes, & Pianta, 2012	PreK CLASS	State-funded prekindergarten programs in 11 states 57 Spanishspeaking 4-year-old children no educator demographics reported child assessments were conducted	CLASS has similar predictive validity for DLL children as it does for monolingual children. Children who experienced classrooms with higher levels of Emotional Support, as measured by CLASS, had higher reading and math scores. Children with more instruction in Spanish had higher math and reading scores. Instruction in Spanish can promote reading and math skill development among these very vulnerable children struggling to learn English, especially when they attend high-quality programs. PreK CLASS IS (n=267, M=1.97, SD=.86

Appendix C: Evidence Regarding LatinX Educator Science Education

Reference/ Citation	Specific Components of Approach or Model	Population/Participants (s)	Study Findings
Tu 2006	Pilot Study: A pilot study was conducted with two multiage preschool classrooms in a Midwestern university-based laboratory school. Assessments: The Preschool Teacher Classroom/Sciencing Form (inter-observer reliability 95.83%) analyzed teacher child-interactions on two consecutive days during the free playtime. The Preschool Classroom Science Materials/Equipment Checklist and the Preschool Classroom Science Activities Checklist (inter-observer reliability 100%) were conducted following the first day of recording.	Educators: All participants were White/Caucasian females (Bachelor's degrees (60%), Attended a junior college or equivalent (15%), High school diplomas (25%)) Having 1-3 years of teaching experience (35%), 4-10 years of teaching experience (40%), 10 years or more (25%)	The study is mapping preschool educators' engagement to be unrelated to science activities (86.8%), 4.5% of the activities were related to formal sciencing, and 8.8% of the activities were related to informal sciencing. Preschool children miss the opportunities to develop and enhance their scientific skills, such as observing, comparing, organizing, and classifying, because there weren't any sorting objects in the classroom. Further, most science materials were "natural items, such as feathers, pine cones, seashells, fossils, plans, and toads. The researchers show that the science area is not available in all classrooms (only half of the preschool classrooms had a science area).
Tu & Hsiao 2006	Same approach as Tu (2006)	Same as Tu (2006)	The study explores preschool educators' teacher-child verbal interaction in science teaching. Educators are interacting with children most often in the art area (24.8%), and the sensory area (19.3%), and science (.3%). Further, this study depicts the amount of science teacher-child interaction over two days. On the first day, teachers used more praise, acknowledgment statement, and closed questions than on day two, where a science activity was provided for educators. On day two, educators used more learning guidance, information talk statement, and more attention-focusing question. They lead the study to conclude that there is a "need to expand [educators'] knowledge of science to increase their familiarity and comfort level and integrate science more rigorously into their classroom. A way of motivating educators' engagement in science is for educators to begin tapping into community resources. In other words, professional development provides educators with the necessary skills to scaffold a child's thinking and prompt concept development.
Greenfield et al. 2009	Focus groups: This study involved twelve different large, small Head Start centers from different parts of	Background: a review of the content and process of 29 early learning standards for science learning and 10 preschool	The researchers conducted an extensive literature review of standards and curricula; a national study of the content and process of 29 early learning standards for science learning and 10 preschool curricula

	the county. Each meeting had about 4 to 10 teachers present. ECHOS: The program was field-tested during the second half of THE 2004 -2005 school year (December through May) with a small group of Head Start Teachers. The purpose of ECHOS is to provide teachers with "resources needed for teachers to increase their confidence about teaching science and to help them adjust their classroom schedules to teach science through the integration of multiple school readiness domains within science activities." Educators voluntarily enrolled in the ECHOS training (treatment), and those who didn't were the control. Each classroom had about 15-20 children present.	curricula identified Study 1: assessed statewide data from the 2002-2003 and 2003 - 2004 Head Start school year. Study 2: No mention of educator or child demographics. Study 3: No mention of educator or child demographics.	identified eight essential process skills: observing, describing, comparing, questioning, predicting, experimenting, reflecting, and cooperating. These common process skills emerged from three broad content areas: Life Sciences (42% of all entries), Earth/Space Sciences (27%), and Physical/Energy Sciences (31%). The aim was to ensure that these practices positively impact young children's science readiness by establishing causal links between this classroom practice and science readiness. The first study reviewed statewide data from the 2002-2003 and 2003-2004 Head Start school year showing "children end their pre-kindergarten year with science readiness scores significantly lower than readiness scores in all other measured domains." The second study identifies "low self-efficacy in science and time-management issues as two possible barriers for why preschool teachers may have difficulty teaching science." For example, educators are describing difficulty finding enough time to provide children with learning experiences in all readiness domains, including science, within the framework of a busy daily routine. Their final study provided a 2-day training for teachers on Early Childhood Hands-On Science (ECHOS) and found significant science child learning gains.
Nayfeld et al. 2011	Phase I: Collection of baseline observation of children's play in the science area during their free choice time and an individual interview to determine an intervention measure about the balance scale and its function Phase II: In the intervention phase, children in experimental classrooms participated in two large-group lessons about the balance scale. Phase III: Included post-intervention observation of the science area and post-intervention interviews.	Control: 15 sets of pre-and post-test interviews from children (12 girls) Experimental: 19 sets of pre-and post-test interviews from children (14 girls) Children: 90% predominantly Hispanic Teachers: No demographics were reported	Researchers are showing that it is not enough to have science materials in the classroom educators need support on ways to use science materials. The study shows the overall number of child minutes increased from 76 to 638 in the experimental condition and decreased from 224 to 67 in the control condition.
Edwards & Loveridge 2011	An initial interview with each participant to gather their background and ideas on what science is and how science learning might be supported early childhood.	Educators: Six fully trained educators were between 20 and 25 years old. Four were of European descent, one of Maori descent, and one an Indian immigrant. All had studied science in high school and had	The study shows that educators' belief system influences their teaching pedagogy. The researchers report, "participants' knowledge bases increased by the interests of the children, parents, other teachers, and wider community knowledge that is locally contextualized, relevant to the child, and open to both local and

	Across three days, participants gathered documentation on situations where they recognized children engaging in science. Dictaphone and note-taking equipment. Digital camera to take photos (most popular). In the final interview, participants talked about the data they had collected after the three days of data collection. Specifically, "what they did, or might do, to respond to the situation." Member checking as well as a group discussion with all participants	obtained their teaching qualification from the same institution. Children: 35 children between 18 months and five years, with no more than 28 at any given time.	global perspectives. In this way, "there are multiple ways teachers' negative perceptions towards science might be challenged and changed." Further, educators "who are unsure or have misconceptions of what science still supports children's working theory around nature of science, whether they are aware of it or not. However, their teaching decisions are influenced by other "more pressing needs and teaching demands requiring their attention." For example, "They [the children] ask questions, and you've got 50 million things to do and a baby that you're feeding. So if you can, remember to come back to it, or grab them a book or something that they can look at for themselves." Specifically, educators who demonstrated less understanding of science were inhibited by a lack of confidence in their ability to scaffold scientific thinking with children. In other words, educators are shaping a child's science identity whether they are aware of it or not. Further, "[educator's] ability to work within a team can increase their ability to support children's scientific thinking." Moreover, the practical implications of this study are to situate science learning to be constructed from several sources, including personal perspectives, social and cultural aspects of education, and daily interactions between individuals, social groups, and context. For example, "[educators' knowledge base increased by the interests of the children, parents, other [educators], and wider community."
Maier, Greenfield, Bulotsky-Shearer 2013	(1) Teacher comfort consists of 14 items measuring the educator's comfort with planning and demonstrating different science activities. (2) Child benefit consists of 10 items assessing educators' attitudes and beliefs toward how preschool science fosters children's interest in science is improving their school readiness skills. (3) Challenges consist of 7 items reflecting educators' negative attitudes and beliefs toward teaching science, including their discomfort and concerns regarding their ability and	Validation sample: Educators (n=30) in total, "where 20 were participating in the science curriculum training and 10 were comparison teachers who were not participating in the training. All of the teachers were female; 19 teachers were Hispanic or Latino, eight were Blank or African American, one was White or Caucasian, one was Asian, and one did not report race/ethnicity. Eleven educators completed a bachelor's degree, and three completed a master's degree." The number of years they had been in preschool ranged from 0 months to 30 years. Study: Educators (n=507) were 98% were female. "Thirty-four percent were White or Caucasian, 34% Blank or African American, 26% Hispanic or Latino, 5%	The researchers developed the Preschool Teacher Attitudes and Beliefs Toward Science (P-TABS), assessing three components: teacher comfort, child benefit, and challenges. The study findings were as follows: (1) Teacher comfort: Educators, on average, felt comfortable conducting science activities in their classroom and believe preschool science is beneficial for young children. (2) Child benefit: Some mild disagreements for statements regarding science as a subject that is "too difficult for young children." (3) Challenges: Educators endorsed low levels of comfort regarding "planning and demonstrating classroom activities related to physical and energy science." Furthermore, educators' responses indicated lower levels of discussion of "ideas and issues of science teaching," suggesting educators do not use other resources when teaching science. In short,

	the amount of time needed to do science activities.	other ethnicities, and 1% did not respond to this question. Fifty-one percent of the teachers completed a CDA or other associate's degree, 38% a bachelor's degree, 10% a master's or doctoral degree, and 1% did not respond to this question. Ninety-one percent of the [educators] reported that many years they had been a preschool [educator], which ranged from 0 months to 42 years." All participated in various professional development actives, which impacted their science-related knowledge and understanding.	educators' responses indicate the adequate level of comfort to teach science, agree that science early on is beneficial, but have difficulty embedding science along with the day-to-day care and education responsibilities
Merino et al. 2013	Information was gathered through a questionnaire and cognitive maps, as well as through a qualitative approach.	No demographics were reported of the center, participants, and children. Educators: Phase 1: Sixty-one preschool educators from Valparaiso Region (Chile) answered the questionnaire. Phase 2: To validate and ensure the accuracy of the data collected, nine educators were chosen - using a non-proportional stratified sample - were considered for a one-year follow-up. (1) field records, (2) Interview of practical arguments. Selected video recordings are shown to the educator, and questions were asked to triangulate data.	The research captures the amount and level of science learning being created when community knowledge is ignored. The study is conducting a mixed-methods study in Chile. In the first phase, a quantitative analysis is showing, "that for 61 [n=61] teachers science is an activity socially and historically conditioned, conducted by scientists who have different strategies that involve creative intellectual process, empirical validation and critical selection, and through which a changing temporary and relative knowledge is built." The researchers describe four different models representing the formulation level of the concept of science: (1) Traditional, focused on verbal transmission, (2) Technological, focused on goals as the axes of practice and as the reference to assess students' learning, (3) Alternative, makes an emphasis on the complex character of the relationship between the child's participation and the educator's role (58%), (4) Hybrid, characterized by a rationalist view of science looking for true, definitive and unquestionable meaning or knowledge, and at the same time, believes in the existence of constructivists and evolutionary realities (59%). In other words, teaching science with an effectivist approach, directive and teacher-centered role – using didactic tools, and in doing so, demonstrating certain contents are correct. The second part of the study followed nine preschool educators to characterize their beliefs about science. They found "[educators] attitudes do not reinforce (does not consider) verbalization and observation of the children that are not going on the expect path ("correct") and promote the repetition of the ones considered right by giving rewards." Further, "children [are taught science by] only observing teachers' behaviors and instruction, learn[ing] through symbolic representations (meanings) and social classroom situation related to the contents and activities conducted."

			In other words, such a directive approach results in the ineffective quality of feedback and concept development to scaffold a child's thinking.
Fleer & Gomes 2014	This s a case study examining the classroom environment and the teacher's beliefs of realizing science learning opportunities throughout the day of a child in care.	Center: The center is in a middle SES community location used by other community organizations (i.e., bridge club, martial arts, pilates and language classes, etc.)."The center is of historical significance to the community and is located in an attractive part of the small coastal town. Many of the children and families know each other from other community activities." Educators: The program, operating for three years, is led by a Bachelor's degree qualified teacher director and a Certificate III qualified assistant. A retired volunteer from the community is regularly helping. Children: The program serves about 65 children (aged from 3.3 to 4.6 years old) who attend one or two days per week, with a five-hour session. Approximately 25 children attend each session.	The study mapped science learning affordances in preschool classrooms by analyzing photographs (indoor and outdoor), video recordings, and think aloud of an educators' science walk. The research identifies the large amounts of science opportunities already present in preschool settings. The researchers state, "sciencing attitude of the teachers is likely to maximize the scientific learning opportunities of young children." Where "conceptual development in science is more likely to be consciously considered by the children along with their [educators] at the higher level of thinking in new ways about the everyday world." However, the indoor and outdoor spaces matched with science concepts are constructed through director-teacher walking researchers through a science walk. There is no member checking. This raises a pressing concern, are educators able to recognize science opportunities (content and process) and engage in learning – wonder and excitement with young children.
Aslan, Tas & Ogul 2016	Science Teaching Efficacy Belief Instrument: consists of 21 items, including positive and negative statements. Personal Science Teaching Self Efficacy Belief subscale (13 items: 5 positive and 8 negative) Science Teaching Outcome Expectancy sub-scale(8 items: 7 positive, 1 negative)	Educators: in-service preschool educators (n=73), first-grade pre-service preschool educators (n=50), pre-service preschool educators (n=50) Educator demographics not reported	Findings show in-service educators had higher science teaching efficacy belief scores than pre-service educators. Further, last-grade pre-service educators had a higher science teaching efficacy belief score than first-grade pre-service educators. Moreover, pre-service educators graduating from mathematics and science departments at high school had more sciencing teaching efficacy belief scores than those who graduated from the literature mathematics department. Finally, educators teaching more than 10 years have higher science teaching efficacy beliefs than those with less teaching experience.
Pendergast et al. 2017	(1) Teacher comfort consists of 14 items measuring the educator's comfort with planning and demonstrating different science activities.	Participant demographics: gender: 97% were women age range: 25-34 years (66%) followed by 50 years or older (66%) ethnicity: White (61%) followed by	The research study extends efforts from Maier et al. (2013) to assess the attitudes and beliefs of prekindergarten educators towards teaching science to preschoolers. Teacher Comfort

(2) Child benefit consists of 10 items assessing educators' attitudes and beliefs toward how preschool science fosters children's interest in science is improving their school readiness skills. (3) Challenges consist of 7 items reflecting educators' negative attitudes and beliefs toward teaching science, including their discomfort and concerns regarding their ability and the amount of time needed to do science activities.	African American (34%) (50%, 110 responding) participated in professional development opportunities related to science within the past three years (82%, 112 responding) request for future professional development opportunities specific to science teaching	The study is showing preschool educators: - enjoyed teaching science weekly, and integrated science in literary activities (<90%) - felt comfortable teaching life, earth, and physical science, using a variety of resources to obtain ideas for science-related activities, and believed science should be introduced to children early on (<90%) Child Benefit Almost all respondents "strongly agreed" or "agreed" that children are curious about scientific concepts and phenomena and felt preschool science foster an interest in science later in life (<90%). Challenges The study is showing preschool educators: - were not fearful of science information or their abilities to teach science - 73% of participants indicated they felt comfortable talking about the scientific method - 81% indicated they were not afraid of children posing scientific questions they may not be able to answer - 79% felt they had enough scientific knowledge to teach science - 52% indicated they would teach science daily, although preparing for science activities required more preparation time than other subject activities