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Teacher Insights and Facilitation of Equitable Learning Environments for Diverse and English Language Learners in Science Classrooms

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ACCEPTANCE

This dissertation, TEACHER INSIGHTS AND FACILITATION OF EQUITABLE LEARNING ENVIRONMENTS FOR DIVERSE & ENGLISH LANGUAGE LEARNERS IN SCIENCE CLASSROOMS, by JAMIE DANIELS-FAVORS, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

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PRESENTATIONS

Unstandardizing Education for Academic Equity for All **SASTE Conference**
University of West Georgia October 2019

Equitable Learning Spaces in the Classroom **Sources Conference**
Georgia State University October 2019

TEACHER INSIGHTS AND FACILITATION OF EQUITABLE LEARNING ENVIRONMENTS FOR DIVERSE & ENGLISH LANGUAGE LEARNERS IN SCIENCE CLASSROOMS

by

JAMIE DANIELS-FAVORS

Under the Direction of Patrick James Enderle, Ph.D

ABSTRACT

The number of diverse students within the American school system Is growing vastly. Researchers predict that "language minority students" will comprise over 40 percent of elementary and secondary students by 2030 (Thomas. Collier, & National Clearinghouse for Bilingual Education, 1997). English language learners are the fastest-growing learner population, with 60% within the last 15years (Breiseth, 2015). However, the school setting does not adequately serve the needs of diverse students and. more so, those that are Culturally and Linguistically Diverse (CLO), such as ELLs. This study intends to examine how science teachers are creating equitable learning spaces and experiences within their classrooms for English Language learners and other diverse learners. The main research question that was studied is 'In what ways do science teachers conceptualize equitable learning spaces and experiences within their classrooms for diverse language learners?'. The research question was examined through Interviews and focus groups. The significant findings of this study are that teachers play an essential role In creating equitable learning environments. It is challenging and complex for teachers to build these environments for students without the support of equity-focused professional development. Teachers can develop their pedagogical design to exceed Banks' (1998} multicultural approaches past level two through equity-focused professional development.

Students are essential, their backgrounds are Important. and their cultural differences are an asset to their learning. In the classroom, students should not feel like the inaccessible curriculum is penalizing them because of their cultural background. We cannot change our backgrounds or ethnicities, and they should not be held against us, especially in schools

INDEX WORDS: Equitable education , English language learner, diverse learner, science education

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1 THE PROBLEM

Background of English Language Learners

An English language learner (ELL) is the term used to describe students between the ages of three and twenty-one and have limited English proficiency. Title VII of Improving America's School Act of 1994 states that a student who has a limited English proficiency has a significant difficulty reading, writing, and comprehending English. This limited English proficiency can allow a student not to participate in classroom environments where instruction is delivered solely in English (Rhodes, Ochoa, & Ortiz, 2005). English language learners are also students from non-English speaking homes, and scholars refer to this as a primary home language other than English (PHLOTE). Most ELL students will take five to seven years to develop a command over the English language, with usually a social command first. (Collier, 1989: Cummins, 1981). Equitable learning environments that provide access to the curriculum are needed for ELLs to develop the academic language needed to perform in schools.

Factors such as limited English proficiency and rushed learning of academic English in schools pose a need for classroom instruction to be modified to fit the needs of English language learners, thus creating an equitable learning space. According to Anth (2019), there are four primary levels of English language proficiency. These levels are newcomer/limited English, limited to moderate English, moderate English, and moderate to reaching English proficiency. The four levels of English proficiency have different supports to help ELLs become successful in the classroom. These levels have to be adapted based on the different curriculum. Examples for level one includes things like using pictures, working with manipulative, and providing translators. Level four, the highest level, includes supports such as pre-created outlines and not penalizing

students for spelling. Supports referred to previously are necessary for teachers to create equitable learning spaces so that ELLs can access the content. These supports are not capable of being fulfilled without highly qualified teacher facilitators, and the support of other policy-making stakeholders in education, such as administrators and superintendents.

As reported by the National Center for Education Statistics, English Language Learners make up about 10.1% of public-school students in the United States. The percentage of 10.1 represents about 5 million students within our school systems. Within the state of Georgia, the average is 6.1% or about 110,000 students. Georgia school districts with more than 1,500 ELL students were found mostly in the metro Atlanta area, and the most common language spoken among ELLs is Spanish, according to the Migration Policy Institute in 2018 (Sugarman & Geary, 2018). The growth rate of the foreign-born population in Georgia has grown considerably at 233 percent between 1990 and 2000, but recently between the years 2000 and 2016 slowed down to 80%. However, there are about 21% of school-age children that have one or more foreign-born parents. So how are school systems within Georgia identifying ELL students, and what are they doing to accommodate them?

In Georgia, when students arrive at a new school, their PHLOTE has to be identified, and then the student has to be screened for eligibility for language assistance. The student is screened by their parents or legal guardians, completing a home language survey. This survey has questions such as "Which language does your child best understand and speak?" and "Which language does your child most frequently speak at home?". The next step would be for the student to use World-class Instructional Design and Assessments (WIDA). WIDA is a group of assessments that place students on different academic levels for public schools in Georgia. Georgia is a part of the WIDA consortium, which includes 39 other states. The WIDA consortium developed

English language development standards and language proficiency tests aligned with those standards. The five WIDA English Language Development (ELD) standards are broad overarching standards. Their purpose is to successfully be integrated into the Georgia Standards of Excellence (GSEs) in the core content areas to facilitate a space where students can reach academic achievement. For science, the English Development standard for WIDA is for students to communicate information, ideas, and concepts necessary for academic success in science. WIDA is also responsible for the ACCESS for ELLs tests, which are given annually to all English Language Learners in Georgia to measure their progress in English. The WIDA assessments understand that students who are culturally and linguistically diverse bring a unique set of cultural assets that enrich all learners' and educators' experiences. They want to help educators focus on what ELLs can do to contribute to their classroom learning environment (Wisconsin Center for Education Research, 2020). Although WIDA understands the worth and has worked to bring the diverse richness cultures into the classroom learning environments, the classroom learning environments are often not equitably welcoming to the richness of the cultures within science classrooms.

English language along with other diverse language learners do not have equitable access to teachers and classroom learning environments highly qualified to teach them. The inequitable access does not mean that teachers do not want to be able to provide equitable learning spaces; they might not have the pedagogical tools to do so. According to the National Academy of Sciences, Engineering, and Medicine (NASEM) (2018), schools need to re-evaluate English language learner instruction to ensure that students receive high-quality instruction and how ELLs are positioned in the science classroom. Schools should review the qualifications of potential

new ELL teachers hired and the professional development offered to teachers. To teach ELL students, teachers are required to complete and ESOL Endorsement course. These courses could be completed at a college, university, or within a school district. According to Brenau University, ESOL endorsement courses include classes such as foundations & cultural issues for teaching ESOL, language acquisition & development for teaching ESOL, and methods & materials for teaching ESOL. Other schools such as Kennesaw State University and Georgia State University have students take Applied linguistic courses and have students do field experiences. Teachers participating and engaging in endorsement courses are an excellent way to start ESOL teachers on their learning journey of teaching ESOL students. However, further support remains necessary to maintain highly qualified ESOL teachers in the classroom for extended careers.

When ELL students do not have highly qualified teachers that engage students with high-quality instruction, English language learners (ELLs) are not given adequate access to science content in science classrooms. The Georgia Standards of Excellence for Science (Georgia Department of Education, 2015) are based on the Next Generation Science Standards (the NGSS Lead States, 2013). Georgia adopted standards that are three dimensional, which focus on integrating content with science and engineering practices and crosscutting concepts. The GSEs are more rigorous and move away from rote learning that requires students to define and recall and evolves to instruction that engages students in constructing arguments, using scientific models to explain phenomena, and grow their ability to obtain, evaluate, and communicate, the practice that grounds each standard. Another critical component to the GSEs is anchoring learning in exploring and explaining phenomena from the natural world. Using science to explain a natural phenomenon is a way to make thinking visible so that students can make sense of science concepts in relation to their lives. The last highlight about the GSEs relevant to this study is how the

GSEs need to support diverse learning populations such as ELLs and how to make science accessible or all students.

Research suggests there needs to be a shift in how the assets that ELLs bring into the classroom, and the understanding that some deficits in student performance are because of the lack of access to the curriculum and not from the limited ability (NASEM, 2018). According to Merriam-Webster (2020), access is the right or opportunity to benefit from something. When students such as ELLs are not given adequate access to science content, this limits the creation of equitable learning spaces, and the benefits students receive. According to the American Educational Research Association (2004, 2009, 2012), access to high-quality curriculum, instruction, and teachers is effective in supporting the academic success of ELLs learning English and academic content .

Barriers to Science for ELLs in High School

High school can be seen as when students are given a bit of freedom to discover what their real interests are when it comes to school. Students are usually given a choice to start making decisions towards their prospective career paths. However, ELL students are faced with barriers to science learning because of poor advising regarding their course selection, exclusion from rigorous science courses, and placement in remedial courses. All those factors limit access to ELLs to the learning of advanced STEM subjects and STEM careers (National Academy of Sciences, 2018). However, studies show how schools and teachers are usually unaware of all the exclusionary practices of ELLs and how they impact adolescent identity development and their future trajectories (Verhoeven et al. 2019). While completing their graduation requirements, students are given opportunities to explore their interests in different core subjects. For example, in science content, in most high schools, ' students are allowed to choose their fourth-year science

class. ELL students, on the other hand, do not always get allowed to make those choices. For some ELL students, their schedules are already jammed pack with courses so that they could have the opportunity to graduate on time. This choice has been decided for some ELL students because of their previous academic environments. In this situation, ELL students are already denied the opportunity to explore scientific content they find interesting. As a classroom teacher for ELL biology and a fourth-year science forensics class, I have witnessed many students who get so sad because they cannot take a fourth-year science class like forensics because their schedule is already filled with other essential core classes. For most ELLs, there are few choices for them when other students are given many opportunities to choose what classes they want to explore. ELL students are already faced with barriers to learning science, such as limited English proficiency. When ELL students arrive in our classrooms, their only barrier to learning science should be their limited English proficiency, not their cultural background or experiences. Students should be able to enter an equitable learning space that allows them to have power in their learning and be a part of a learning community that respects their culture and experiences. Unfortunately, all classrooms are not equipped to provide this environment for ELL students to have unrestricted access to content that could create opportunities for them to engage, understand, and apply information that could evolve into students becoming a part of future stem professions.

The Need for Equitable Learning Spaces

Equitable learning spaces are environments where the whole student is involved in the learning process. Non-equitable learning spaces involve learning environments where students are taught in ways that view their prior knowledge, linguistic resources, and the culture as deficits to their learning and something they need to overcome. Deficit teaching occurs when the curriculum does not reflect the diverse student body expected to engage with it. Productive learning

environments will have a curriculum that provides a plethora of diverse opportunities for speaking, listening, reading, and writing and engage students in instruction that will encourage students to take risks, construct meaning, and seek different understandings and applications of knowledge within the daily lives (Garcia and Gonzalez, 1995, p. 424). In an equitable learning space, students are empowered to think critically, are invested in their learning, are a part of a learning community, and are empowered because they have a voice in their learning.

The Power of Equitable Learning Spaces in Science for ELLs and Other Diverse Learners

According to Garza and colleagues (2017), the academic language of science that includes technical vocabulary can be both challenging and conceptually crucial for developing and understanding scientific content. Students have to argue to support and tease out their ideas about science and how to critique the ideas of their peers (Buxton, Suriel, & Choi, 2012). All students grow up in communities that use the vehicle of language to engage in cultural practices that were developed historically, and each community has a way of conceptualizing, representing, evaluating, and engaging with their environment (Nasir et al., 2014; Gutierrez and Rogoff, 2003). Children are usually socialized in the ways of their local communities first (Gutierrez and Rogoff, 2003). Creating equitable learning spaces makes sure that the cultural and linguistic assets that students such as ELLs bring to the classroom are accepted, respected, and used as an asset within their learning (Lee & Buxton, 2006). When students are taught at a deficit, they are indoctrinated to think their cultural assets are less than, because they are different.

Students feeling they are not necessary because of their cultural background and linguistic capabilities can easily translate into students not even being interested in Science, Technology, Engineering, and Mathematics or STEM-related fields or career interests. Landivar (2013) found that in 2010 the disparities of students receiving a STEM bachelor's degree were 88.4%

for Whites and Asians, but African Americans and Hispanics only represented 9.9%. One of the most underrepresented groups among STEM bachelor's degrees in English Language Learners, which needs to change (Shi, 2017). Shi conducted a study examining the different factors that affect ELLs obtaining STEM degrees and being a part of STEM careers. They found that Black ELL students were taking significantly more STEM courses than Hispanic ELLs. Research on STEM demographics found that 69% of STEM workers in the United States are white, followed by Asians with 13%, blacks with 9%, and Hispanics with 7% (Funk & Parker, 2018). There is a clear over-representation of whites and Asians in the STEM workforce, and part of that can be credited to inequitable access to engaging STEM curriculum in schools. Lee and Buxton (2010) argue that addressing inequitable learning opportunities for underrepresented students should focus on valuing the knowledge and experiences students bring to the classroom, articulating a students' funds of knowledge and offering sufficient resources to support the learning of these students. Students can be lumped into what seems like similar categories because of their assumptions (Nieto, 1999). Equitable learning spaces give power to each student's differences and make room for the various experiences that students have in and out of the classroom. The goal of this power is not just for students to be a part of a stem career but also for them to be more aware of the world around them. Science learning environments also offer them opportunities to facilitate a space where students learn how to articulate their thoughts and firmly held beliefs through techniques frequently used in science, such as argumentation. Equitable learning spaces in the science classroom create a space where all experiences have a place and are an asset to the learning environment and not treated as a deficit.

The Impact and Needs of Teachers

Teachers are who make creating equitable learning spaces in the classroom and, in particular, the science classroom possible. We are on the ground working with students and interacting with them every day. However, teachers are not able to provide access through equitable learning spaces to the curriculum for underrepresented groups in STEM, such as ELLs, with limited access to professional development that is research-based and targets the needs and strengths of ELLs in STEM to help them be and continue to be successful in the STEM classroom. In the long run, the lack of equitable learning spaces in science classrooms that lead to a lessened interest in STEM fields can translate to students who are culturally and linguistically diverse, not having a seat at the table, or even creating their table (Harper, 2019). The phrase 'a seat at the table' means that you have the opportunity to understand or be a part of policy decisions and other significant events that can impact their community directly. Simply put, they will have the voice and power to make decisions that impact not only them but their entire community.

Teachers creating equitable learning spaces are essential to creating an environment where learning can be done across various cultures and experiences. Research shows that ELLs are interested in STEM and can understand scientific content, but are usually limited to their choices to expand their learning because of assumptions of their abilities (Harper, 2019). One of the features of equitable learning spaces is the opportunity for students to have the power within the learning space and feel empowered outside of the classroom. Students having power in the classroom removes the act of students being passive members of the classroom and creates a space for students to be agents of change for themselves, their peers, and their communities. When students participate in a classroom passively, they are mainly "sitting and getting," which means they come to class and take in the knowledge they need to do their work, turn it in and get

good grades. The information the passive student learns in class has no power in their life, and the information just needs to be remembered for regurgitation on an assessment later. The students in our classrooms are the adults of today and tomorrow and should be active participants of their learning. As a secondary high school science teacher, I feel that students should be empowered by the information they learn and feel they have the power not to agree with everything they have to learn. Not saying that everything that students learn in my biology or forensics classes should be held at the utmost importance for my students, but when they leave at the end of the semester, I hope that there is some concept we discussed that triggered a way for them to do something good in the world. Teachers can be seen as the gatekeepers of education, and the same is valid for science education. Often teachers evaluate and offer guidance to students as they matriculate through high school and home in on their career goals. While this can be beneficial to students, such as language minorities, this guidance can negatively impact their trajectories after high school. Teachers' perception of their students' abilities profoundly impacts the shaping of student's academic outcomes (Blanchard and Muller, 2015).

For high school science courses, the GSEs want students to engage in science-based practices that provide foundational knowledge for students who want to become scientists and technicians of the future (Georgia Department of Education ESOL Resource Guide, 2018). Scholars like Lee & Buxton (2010) note they can be accomplished if teachers are given opportunities to participate in professional development that creates an environment for a broader array of knowledge, skills, and dispositions to provide equitable learning opportunities for all students their classroom. Even though there has been a growing awareness of the need for better professional development that addresses ELLs' needs, limited progress has been made to prepare teachers better to succeed in today's culturally and linguistically diverse classrooms (Buxton & Lee,

2014). According to the Hanover Research foundation (2017), teachers need to have opportunities to explore the intersectionality between ethnicity, socio-economic status, culture, and race as dimensions to diversity. Teachers also need training. This means teachers need to have the opportunity to engage with their peers in skill-based training that is focused and specific to the community they teach. Overall, teachers need a safe space to explore the culture and also a safe space to explore how their curriculum and the culture of their students can work in symbiosis.

Statement of the Problem

The number of diverse students within the American school system is growing vastly, and researchers predict that "language minority students" will comprise over 40 percent of elementary and secondary students by 2030 (Thomas, Collier, & National Clearinghouse for Bilingual Education, 1997). English language learners are the fastest-growing learner population, with 60% within the last 15 years (Breiseth, 2015). However, the school setting does not adequately serve the needs of diverse students and, more so, those that are Culturally and Linguistically Diverse such as ELLs (CLD). It has been well documented that ELLs have less access to learning experiences that support science practices that can be found in the GSEs than their English-speaking peers (Callahan, Wilkinson, & Muller, 2010). With the increasing number of ELL students in our classrooms within the United States, it is essential more now than ever that we require that today's teachers and tomorrow need a new set of pedagogical skills and dispositions different from the teachers that came before them. All of this has to be done to create equitable learning opportunities for all students, not just English language learners, but all students (Buxton & Lee, 2014). When providing equitable learning and assessment opportunities for ELLs, students can demonstrate high levels of science achievement. ELLs' opportunity to demonstrate high levels of science achievement allows ELLs to take agency and ownership of their science

learning and the space to develop positive attitudes towards science, which can flourish into potential careers in science fields. Most of the academic barriers that ELLs face in the science classrooms are rooted in the structure of the education system and least likely due to their families or communities. Students, such as ELLs who have traditionally not performed well in science, deserve equitable learning spaces and equitable assessment practices. States, districts, and schools need to consider how they allocate resources such as human capital and social resources to support English language learners to learn the rigorous science standards like the GSEs while learning the English language simultaneously.

Purpose of the Study

Diverse education is needed to help diverse learners succeed, both academically and socially. Standardized education is only built for white students, and in our growing demographics in the U.S school system, it is time that we recognize and accommodate all learners to give them equal opportunities to meet their ideas of academic and social success. Schools are a racist institution at the core with the first purposes of education for African Americans to get a utilitarian education while white people were given access to literacy education, and that is where the first divides began (Watkins, 2017). From this viewpoint is where deficit education emerged. Every type of student that enters a classroom actively needs to be able to see themselves in the content taught to them in school and the classroom, so that skills they learn will be transferable to their daily lives. America is always referred to as the Land of Immigrants, where diversity should be celebrated. If diversity is to be celebrated, this should be most evident in our public-school systems.

The intentions of this study was to examine how science teachers are creating equitable learning spaces and experiences within their classrooms for diverse and English Language learners and how these decisions support the learning of their students.

Research Questions

The main research question that was examined is:

1. In what ways did science teachers conceptualize equitable learning spaces and experiences within their classrooms for diverse and English language learners?

Significance. Voices and ideas need to be heard. As a teacher, I felt like my voice can be silenced frequently when it comes to my classroom needs. I know I was not the first teacher that realized that our schools need to be more equitable, but hopefully, I am a teacher that will contribute to a solution instead of complaining about the problem. When reading and combing through literature, it is more than evident that scholars know that our classrooms should be places where student's backgrounds and ways of knowing the world should be honored, however, more information should be available when as it pertains to how science teachers in high school are trying to create equitable learning spaces among our current educational climate. During this current school climate in 2020, many factors affected how students learn. Movements were going on, such as Black Lives Matter, children of immigrants being put in cages, people losing their lives to a global pandemic, and that is just to name a few. While all of this was going on, students were still charged with going into the classroom and engaging in content that may or may not be relevant to their culture, background, or communities. Not to mention teachers were charged with needing to have an ability to teach students during this climate and make sure students could achieve mastery. This is all while just dealing with factors outside the school. The factors were somewhat even more intense inside the school for populations like

ESOL students because of the harsh reality some have to deal with and cope with while attending school every day.

Students are essential, their backgrounds are essential, and their cultural differences are essential. In the classroom, students should not feel like the inaccessible curriculum is penalizing them because of their cultural background. We cannot change our backgrounds or ethnicities, and they should not be held against us, especially in places such as schools. The goal of this study was to provide voice, contribute, and learn. I wanted to help give a voice to the teachers about their needs in the classroom and what they are currently doing in their classrooms. I felt like teachers play a large role in providing an equitable learning space for a student to thrive. The next goal was contribution. For the field of science education research and, for diverse and ESOL students , I wanted to provide some more examples of how science teachers were creating equitable learning spaces in their classrooms where factors like social justice can occur. I also hoped my research encourages more teachers to be reflexive in their pedagogical practices to see how they are equitable in their classrooms. I wanted to provide research that provides a better understanding of how to support teachers on how to support the learning of rigorous science content to diverse and English language learners in high school science education. Lastly, I have always strived to be a lifelong learner, and conducting this study allowed me as an educator to learn even more about how to support my students and be a supportive teacher colleague to other teachers seeking information.

2 REVIEW OF THE LITERATURE

Introduction

School districts across the U.S are experiencing rapid growth in the number of students that represent minoritized populations who are linguistically diverse and are from low-income families (Howard, 2007). As a classroom teacher, I experienced this growth as both a student and an educator. Most of the students I taught and interacted with are already bilingual in Spanish and English, not to mention the plethora of other languages that Culturally Linguistically Diverse (CLD) students speak. Culturally linguistically diverse is the umbrella term used for students that are diverse in their culture and language. Throughout this literature review, the terms culturally linguistically diverse and English language learners (ELL) were used interchangeably, therefore as the abbreviated name CLD is mentioned throughout this paper, it referred to the English language learner student population. I focused on the English language learner part of the Culturally linguistically diverse students because ELL are diverse students who have limited English proficiency. This group of students is important to me because I have learned more about them and their struggles. I have also had the pleasure of teaching ELLs throughout my entire teaching career as well as majorly diverse students . Through interactions with ELLs and other diverse students, I have always looked for a ways to help foster an environment that helps them learn more freely and more relevant to their lives outside of school.

Linguistically diverse students also bring different cultural norms that may go against the school norms in which they attend. Every student deserves the opportunity to have access to an education where they can see their culture and diversity as an intentional entity to their learning experience. According to Gonzalez, Moll, and Amanti (2005), as well as Tolbert and Knox

(2016), the capitalizing of English learners' prior knowledge is their starting point for making connections between science and their primary language. Therefore, if these connections between science and primary languages are not made in the science classroom, students will not have access to explore their primary language. The opportunity for students to learn in an environment that engages their culture and their way of understanding as an asset and not a deficit is a way of creating an equitable space in the classroom (Cleveland, 2009).

The word equitable, by definition, means fair and impartial (Merriam-Webster, 2020). Equitable learning spaces mean that students should have equal access to the curriculum and learn no matter their background or prior knowledge. However, with the ability to learn in equitable spaces, educators and stakeholders need to be aware of the messages sent to CLD students when the equitable learning that is taking place in a classroom but then assessed by non-equitable high stakes testing, especially in a content area such as science. According to Bianchini (2017), for science education to be equitable, it has to be transformed. Science education has to be equitably transformed, so it considers inequalities such as marginalization for diverse student groups in the teaching and learning of science. Inequitable science education includes not implementing curriculum, instruction, and assessment that hold students' funds of knowledge as an asset but rather as a deficit within the classroom. Further, the uneven distribution of material, human, and social resources in classrooms and schools are consistent hallmarks of inequitable science learning spaces (Tobin, Roth & Zimmermann, 2001). In this paper, I explored research that demonstrates infusing culture in science curriculum and instruction to create equitable learning spaces in the classroom that were beneficial not just for students that are English language learners but also students with a CLD background. The definition of science in other cultures is broad, and knowledge around the world is grounded in the place where that knowledge is practiced, and

a part of teaching science to diverse learners is making clear and understanding how science is practiced across time and cultures (Shively & Corsiglia, 2001).

Some students enter the classroom with an abundance of knowledge about not one, but two cultures. However, their knowledge of various big "D" discourses might not be used as an asset in the classroom, specifically the science classroom. Gee (1999) characterizes big D discourse as communication that captures the conventions that allow people to enact specific identities and activities. For example, how people use different ways of thinking, acting, interaction, valuing in the appropriate places, and at the appropriate times. For students to be able to participate in the Discourse of science, they have to be able to use scientific ways of thinking and communicating using the socially accepted ways of using language. ELL need to be able to engage in collaborative scientific discourse that allows them to communicate their ideas, reconcile conflicting views, and co-construct shared meaning with other partners (Ash, 2003; Buxton et al., 2013; Chi et al., 2017; Ford, 2012; Reiser, 2004). Essentially, ELL students do not need to just learn about science from books, but they need to have the opportunity to actually "do" science. Research has shown that creating opportunities for ELLs to be able to engage in collaborative scientific discourse is beneficial because it creates more authentic environments that ELLs can have multiple opportunities to develop and use their English language skills to understand scientific phenomena (Allexsaht-Snider et al., 2017; Amaral, Garrison, & Klentschy, 2002; Lee, Hart, Cuevas, & Enders, 2004; Stoddart, Pinal, Latzke, & Canaday, 2002). Unfortunately, not all classrooms are equitably equipped with teachers that can facilitate and engage the different cultural assets and discourses of their students, allowing them to learn, understand and use the Discourse of science in meaningful ways. (Lee & Buxton 2010). These

elements of a students' culture and upbringing are so essential to the facilitation of the learning process (Emdin, 2016).

When the cultural assets and Discourses are not engaged with in the classroom, learning is sterile and not meaningfully transferred to the lives of students. The curriculum cannot be one size fits all, as our students are not identical in their backgrounds. Southerland et al. (2011) point out that our current curriculum and pedagogical practices require reconceptualization for teachers about the goals of teaching, and how the curriculum can operate in the lives of the learners and what the cultural influences are of this learning. There are many students in classrooms across the United States (U.S.) who have similar backgrounds but have diverse life experiences. The different experiences that students bring to a classroom ought to be interpreted as an asset that should be celebrated and not a deficit to their education.

The experiences that students bring to the classroom are classified as the student's prior knowledge or that students' funds of knowledge (Moll et al., 1992). Funds of knowledge emphasized incorporating students' identities and interests into their pedagogical space, along with their conceptual understandings (Jovés, Siqués, & Esteban-Guitart, 2015). The current state of standardized curriculum does not foster the environment to incorporate students' funds of knowledge in the classroom. Students should be able to benefit from a curriculum built with the capabilities to feed their mental, academic, and emotional souls. The current curriculum that is being "fed" to our students is intellectual junk food, according to Noddings (2004). Students are exposed to multiple curriculum types in schools simultaneously, and some are more influential than others. The two curriculums that have the most influence is the hidden and the tested curriculum. The hidden curriculum refers to what students learn from the culture of the school and the implementation of specific policies and practices. The hidden curriculum is a significant part of a student's

experience, and the tested curriculum has an even more significant impact on teachers and students (Alssubaie, 2015). According to Glatthorn (1999), the tested curriculum can be curriculum represented in state tests, district assessments, and teacher-made tests. Stakeholders in education have to be considerate of the message they send to students through the curriculum and assessment in schools. In the next section, I will discuss the current models for the ELL curriculum and instruction. To have a discussion about current learning models for English language learners, it is important to establish context to understand what events happened in the past and how they can inform the future learning environments for ELLS.

Current Learning Model for English Language Learners

In most states, the ELL curriculum is designed for non-native English speakers to develop sufficient verbal and written skills to transition to the dominant all-English curriculum within three years (Valenzuela, 2017). However, studies show that oral proficiency for students with limited English proficiency takes three to five years to develop, and academic proficiency takes four to seven years to develop (Hakuta, Butler, & Witt, 2000). Gandara (2003) states that academic English is the language used within texts and on tests, and academic English is not acquired through colloquial conversations among students. Therefore, academic language has to be taught to students who are not likely to absorb academic discourse within the communities they encounter outside of school. Cummins (1979) points out the distinction between necessary interpersonal communicative skills (BICS) and cognitive academic language proficiency (CALP). BICS can be looked at as colloquial language among peers, and CALP is the academic language proficiency acquired in classrooms or other learning environments. Many stakeholders in education can confuse BICS or colloquial conversations or interactions with a student's ability to understand academic language and practices. When teaching ELLs about new concepts, educators

usually focus on the external features of language like pronunciation, grammar, and fluency, and these would be the BICS and forget about the role that language plays in the thought process, which involves the developments of CALPS (Bylund, 2011). Because of this misunderstanding between the importance in the difference between BICS and CALPS, the crafting of curriculum and educational spaces for ELLs is only equitable when a space for language development is fostered for limited English proficient (LEP) student populations (Cummins, 1999).

Current learning spaces for ELL students are impacted in the secondary science classrooms because of this misunderstanding among educators on the differences between BICs and CALP. Within science classes, there are many language demands, as pointed out in the Next Generation Science Standards (NGSS), that are required for students to be successful within the various courses of science (NGSS Lead States, 2013). Lee and colleagues (2012) state that for students such as ELLs to be able to engage in language intensive tasks found within the NGSS teachers have to be able to facilitate a classroom culture of discourse. The classroom culture has to be inclusive and accepting of the contributions and how they engage in meaning making. With unrealistic language goals for ELL students to learn English successfully, inequitable environments are created within classrooms because teachers are worried about whether they will be able to cover content and be able to get students to achieve high levels on standardized assessments.

Education guided by standardized assessments is crippling the acquisition of knowledge for students, especially ELL students. Embracing a students' CLD background is a part of building equitable spaces in the classroom. For this literature review, the focus will be on equitable learning spaces in the science classroom and why they are necessary. Equitable learning spaces are representative of open and supportive learning spaces that welcome student’s everyday

knowledge and experiences as a part of the classroom learning environment as an asset and give students adequate opportunities to learn science with expectations that every student is capable of meeting high academic standards (Calabrese Barton & Tan 2009; NRC, 2012).

Crafting equitable learning spaces in the science classroom allow student populations such as ELLs to acquire high prestige careers within STEM fields and be able to participate in an increasing science and technology savvy society (Bianchini. 2017). Equitable learning spaces are welcoming environments in the classroom. Equity within classroom learning spaces allows the opportunity for students to engage in science learning that has transformed views of classroom culture. Equitable learning spaces provide learning environments where students have the opportunity to learn using a range of modalities that are suitable to their educational needs. When the culture of a classroom is transformed students also become power agents in the classroom along with the teacher and sometimes on their own (Cleveland, 2009). This literature review will elaborate on why equitable learning spaces are essential and how they are beneficial to science learning within classroom learning environments. The review will also elaborate on how equitable learning spaces are beneficial for CLD students such as ELLs, and how equitable learning spaces in science are beneficial to break down barriers that exist for ELL students to scientific content.

Methodology for Literature Review

The current state of the curriculum and the environment that has been created for ELL students is something of interest to me as a researcher and a classroom teacher. In order to explore this topic further, I thought of and researched several topics that were under the umbrella of ELL science education, equitable learning spaces, and also equitable learning spaces in science. With the information gathered from the literature, a review was constructed analyzing and synthesizing research on the current state of the science curriculum and how it impacted diverse and

ELL students. The terms or phrases that I used to gain further information on the current learning environment and ways to overcome learning obstacles for diverse and ELL students include funds of knowledge, equitable learning spaces, equity in science, culture in science, Next Generation Science Standards (NGSS) and teacher perception of teaching ELLs in science. I used the Google Scholar search engine and also used journal databases accessible through Georgia State University, including JSTOR, ERIC, and others.

The overarching arguments that emerged from this review of the literature include the importance of infusing culture into content for all students, the importance of teacher perception and training, critiques of the Next Generation Science Standards, and best practices in teaching standardized curriculum to ELL students. In the next section, I elaborated on the Next Generation Science Standards and how they affect equitable learning spaces and ELLs.

Background of NGSS

The NGSS (NGSS Lead States, 2013) are national level science standards taught in many schools across the United States in various ways. Some states directly use the NGSS to teach with, but most school districts chose to use the standards as a blueprint or framework for how they went about crafting their own set of science standards (Pruitt, 2014). The standards were made to make sure the expectations were creating a set of research-based and relevant science standards. The following sections discussed how the Next Generation Science Standards came to be and how these new science standards impacted the learning for English Language Learners and diverse learners alike.

History and Purpose of Next Generation Science Standards

There was a two-part process for developing the Next Generation Science Standards. The first part was to develop the conceptual framework (National Research Council, 2012; Rodriguez, 2015). When this framework was developed, it had particular goals in mind: (1) educating all students in science and engineering, (2) providing the foundational knowledge for those who become the scientists and technicians of the future (National Academies Press, 2012). Once the conceptual framework was developed, a different committee crafted the standards. With the introduction of NGSS, many schools wanted to reform their science curriculum to become Science, Technology, Engineering, and Mathematics (STEM) schools without pausing to reflect on the actual logistics of how to have programs that would run correctly (Rodriguez, 2015).

In the history of schooling, there has always been a desire to try and make schooling better by enacting school reforms to bridge achievement gaps between minority groups. For example, in 1983 President Reagan helped formed a committee to craft the *Nation at Risk* report where the goal was to try and demand more rigorous math and science courses to help America be at the forefront of international economies (United States & National Commission on Excellence in Education, 1983). Reforms suggested in *A Nation at Risk* did not look at students and schooling as social and academic development but from a business standpoint. Other scholars such as Becker (1964) and Denison (1964) both have a part in the paradigm shift that the purpose of education was for the forward push of the economy with theories such as human capital, which pointed out the income-enhancing effects that education would bring to the economy. The NaR combined the themes of national security and human capital development. The *Nation at Risk* encouraged reforms whose mission was to develop a student's power of the mind, so they would

be able not to serve their interests but progress the society. Reforms encouraged by *A Nation at Risk* brought about standardized education that had rigorous academic standards.

Fast forward to 2001, and President George W. Bush wanted to continue to reform schools by adding a heightened level of accountability in schools. No Child Left Behind (NCLB), and this initiative made it so that if schools were failing, it was now public information and available on the internet. Having test scores visible to the public was different from 1983 when the public had little information on school performance (United States Department of Education, 2008)). NCLB was composed of four fundamental principles; accountability, flexible and local control, enhanced parental choice, and teaching methods that work. NCLB fostered much on accountability, and less so on the other three aspects. A study done by Rojas-LeBouef & Slate (2011) found that this one size fits all accountability model did not work well in all conditions and limited management and weakens educational changes.

Furthermore, as far as teachers, NCLB did not give teachers enough autonomy to create equitable learning spaces in their classrooms because of unrealistic and unachievable expectations. NCLB held the accountability of performance mostly on the school and teachers and tested students' way more than ever before to close achievement gaps. With the heightened focus on accountability, students that are considered limited English proficient (LEP) are receiving instruction that is mostly in English and limiting to their knowledge, to be able just to pass high stakes tests (Wiley & Wright, 2004). As Rodriguez (2015) points out, no single reform document can be expected to fix the issues that affect the learning opportunities of diverse learners. The NGSS sought to achieve new insights that break away from failed reform patterns that historically have not worked.

Rodriguez (2015) highlights that one of the most significant differences between the NGSS and the National Science Education Standards used in the past is equity. The committee that drafted the standards wanted to incorporate different modalities to engage the role of language, context, social, historical, and institutional factors and how they intersect with facilitating the learning of science for students (NRC, 2012). Appendix D of the NGSS goes into further detail about how particular populations of students, such as ELLs will be affected and suggested classroom strategies that should be implemented. These strategies are literacy strategies, language supports, discourse strategies, home language support, and home culture connections. In the next section of the background of the NGSS critique the impact of the demands of ELL students will be discussed.

How NGSS Impacts ELLs. The population of ELL students is among the fastest-growing of the school-aged population in the United States, yet they are underserved and have the least access to the curriculum (Stoddart, 2014). Also, because of their socio-economic status, ELL students are not adequately served in a classroom with teachers who are equipped with the background or the training to help facilitate their learning (Lucas & Grinberg, 2008). Not only are ELL students with teachers that are unprepared to teach them, but they are also faced with the task of the development of English proficiency with the learning of science content.

The use of language is evident in the NGSS because there is a focus from making the content decontextualized towards focusing on scientific literacy as a productive and integrated use of science language with science content while simulating what real scientists do. In other words, the NGSS wants students to think, talk, and write like scientists while using academic language. For ELLs to be able to communicate using scientific, academic language they have to be able to adapt the communication practices that would be recognized and accepted for these practices

(Wiley & Wright, 2004). The ability to provide this scaffolding to support the language demands of science goes back to teacher education and professional development, as stated by Stoddart et al. (2010). Teachers need to have the ability to recognize and address the language demands of diverse learners and to leverage the content for language learning processes, all while putting a value on students' funds of knowledge. Lee et al., (2014) state that for students to have access to meeting the NGSS in science classrooms there has to be value towards the lived experiences of students, knowledge of cultural and linguistic backgrounds, sufficient school resources, and classroom strategies that are specific for student groups. For teachers to create a space that enables students to meet the NGSS, teachers have to make a shift in their science teaching from conventional teaching they are more familiar with and overall, more comfortable with.

Within the NGSS, there are eight scientific and engineering practices. Within the eight, about four of them are language intensive: developing and using models, constructing explanations and designing solutions, arguing from evidence, and obtaining, evaluating, and communicating information (Lee et al., 2013). The shift in language demands within these standards require changes in the way that teachers facilitate learning in secondary classrooms, especially with those who teach ELL students. Equitable learning experiences for ELL's in science are not only allowing these students to learn through inquiry but also by supporting the rigorous language demands required by the NGSS. Brown (2017) and Moje (2004) note that inquiry is recognized as the gold standard for meaningful science learning experiences, but engagement in inquiry can produce competing Discourses for CLD students such as ELLs. Carlone and colleagues (2011) state that there must be a more significant effort to promote equity in inquiry-based science education by using culturally responsive pedagogical approaches to teaching science as not to marginalize ELLs.

There is a firmly held thought pattern that says that improving language proficiency should occur first followed by teaching content is the best way to teach ELLs science (Bravo & Cervetti (2014). However, Carrejo and Reinhartz (2014) say that for ELL students to be successful in mandated standardized high stakes testing, they need to know and understand certain literacy elements like reading comprehension, vocabulary development, and the representation of information in different ways. Teachers should not choose language development over content but strive to develop the two together through contextualized instruction. By teaching language and content together, the hope is that the language and literacy achievement gap will not continue to widen for ELL students. Teachers are not necessarily prepared to teach in this new way to activate all of the eight scientific and engineering practices (Tolbert et al. 2014).

As mentioned previously, being a teacher of ELLs can be a challenging task when teaching English proficiency and academic content simultaneously. However, the challenge can be conquered by facilitating equitable learning spaces in classrooms that help bring in students' prior knowledge with the classroom's academic content standards and create a welcoming space for learning where mistakes and differences are okay and even welcomed. One-way teachers can create equitable learning spaces in science is by incorporating hybrid spaces into the science classroom that allows for a broader conception of learning than just traditional mastery but helps students make meaning and base it in their experiences (Rahm, 2008). Rahm (2008) did this with one of the participants of their study by helping the student to recognize and value their diverse conflicting concepts and helping them develop different ways of relation to science. The diverse conflicting concepts became building blocks for a new space of opportunity for learning. Another way teachers can create equitable learning spaces that will be discussed is by using multiple modalities and collateral learning. According to Lee, Quinn, & Valdés (2013), NGSS can

provide space for ELLs to learn English proficiency and content, but it depends on teachers sharing the responsibilities of teaching and helping students to develop literacy and numeracy that reinforce each other. Teachers need to understand the importance of infusing culture in science to teach NGSS influenced standards in their classrooms while creating equitable learning spaces.

Infusing Culture in Science

Funds of Knowledge

Throughout the literature, it is clear that infusing culture in science is one of the ways to create equitable learning spaces within the science classroom (Barton & Tan, 2009; González, Moll, & Amanti, 2005). One way to infuse culture in the science classroom is by having knowledge and understanding of your students' funds of knowledge. Funds of knowledge involves a realistic view of households as containing cultural and cognitive resources that are an essential asset to classroom instruction (Barton & Tan, 2009; González, Moll, & Amanti, 2005),. For ELL and CLD students, using funds of knowledge in the classroom is forming an opportunity space that gives the student an environment to make connections from the curriculum to their life outside of school (Rahm, 2008). However, connections that students can make through using their funds of knowledge are not always utilized or given space within the standardized curriculum. The standardized curriculum does not allow space to incorporate a students' funds of knowledge (González, Moll, & Amanti, 2005), and high-stakes testing undermines education by narrowing the curriculum and limiting teachers' abilities to individualize the curriculum to meet the socio-cultural needs of their students (Au, 2017). When teachers have to limit their curriculum to fulfill high stakes testing demands, diverse learners such as ELLs are met with obstacles that limit their ability to make meaningful connections to content learned in the classroom.

Some of the biggest obstacles for ELLs include the ability to communicate in social and academic situations by listening, speaking, reading, and writing (Haynes & Zacarian, 2010). In most schools across the U.S., teachers have a set of standards that frame their teaching practices throughout the year. Standards frame what will be on the classroom and high-stakes assessments throughout the year. This means that for students and ELL students in particular their ability to learn difficult material depends on their ability to be able to communicate what they know about content through being able to listen, speak, read, and write effectively in another language that they may or may not have the full command over. The accountability for teachers to be able to teach district mandated standards and still have enough time to review for assessments can leave teachers with no choice but to limit the curriculum so that students can achieve proficient grades on assessments. By limiting the curriculum because of the need to get through content standards, ELL and CLD students are not given opportunities to use their funds of knowledge to help them navigate through the discourse of science. For example, in a study by Vann and Escudero (2007), a 9th-grade teacher had to limit their curriculum by focusing on vocabulary because they felt that having vocabulary focused tasks was going to help their ELL learners learn science.

However, the educator constrained classroom discourse by having vocabulary focused curriculum and instruction, preventing students from thinking and talking like scientists, which did not help them understand the relationship between concepts being taught or provide them with linguistic resources for conceptual understanding of the content. Not giving an ELL student access to a space including their funds of knowledge and linguistic resources to navigate new content and make connections so that there is better understanding is not creating an equitable learning space. The space to make the connection is not given when curriculum has to be limited to the nuts and bolts or essential standards because the curriculum is just giving access to what

students need to hear in order to be successful on standardized assessments and not to make significant connections to the content that could incite change in students and also within their communities (Tsui. 2007).

The curriculum in U.S. schools is traditionally made to give recognition to students with male white backgrounds within the curriculum and tends to exclude students that have CLD backgrounds (Paris, 2012). This means the curriculum and assessment tools that are being used in schools are not inclusive of diverse cultures. The dominant language, literacy, and cultural practices demanded by the school and recognized throughout the curriculum are White backgrounds, and Discourses that are not in line with White literacies are seen as a deficit and not having any worth in the classroom (Paris, 2012). This lack of respect for culturally diverse discourse, especially within science, is highlighted even more when educators are forced to decide to limit the curriculum so pacing calendars can be maintained and content can be covered. There has to be a transformation in how students are taught. Within the curriculum, there cannot be assumptions that White Discourses will continue to be the only gatekeeper to opportunity and realize that our society is changing (Paris & Alim, 2014). Every student deserves an equitable learning opportunity to have access to those new opportunities and to see how their discourses and ways of being fits into the content they learn in schools.

Diversity should be celebrated, especially within education, by creating equitable learning spaces because diversity promotes learning (Gutierrez et al., 1999). The different demographics of students in the public education system are going to continue to change, and it is up to the education system to model that same change. The curriculum should be accessible to students from many different backgrounds and socio-economic statuses. Swanson, Bianchini, and lee (2014) conducted a study where a high school teacher formulated science, including both

practices and discourse. The teacher defined science discourse as generating and evaluating arguments from evidence, sharing ideas, and understanding others in public settings using precise language. From this approach, the teacher in the study provided their students with multiple, scaffolded opportunities to communicate their ideas about natural phenomena, engaging them in developing arguments from evidence and other scientific practices. One of the biggest scaffolded opportunities to communicate was allowing students to communicate in whatever language they chose when presenting to their classmates. The teacher wanted to make sure that students were able to present in a public forum and also have primary language support. By this teacher creating multiple scaffolded opportunities for their ELL students to articulate their ideas, they extended access to participation in disciplinary practices such as explaining and arguing using the appropriate scaffolding provided by the teacher. This teacher-created an equitable learning space for students by offering multiple modalities that allowed them to use different discourses to be a part of how they learn and understand different scientific phenomena. Teachers can help make their curriculum accessible for all students regardless of cultural background by equitable learning spaces where all prior knowledge and cultural norms have a seat at the learning table.

The conversation about equitable learning spaces and infusing culture in science cannot stop at using students' funds of knowledge in the curriculum. There also needs to be a conversation and transformation at the way students are assessed and how equitable spaces need to be created within assessment also. The participation of ELL students in state and district-mandated testing is because of changes in legislation such as No Child Left Behind (NCLB), and another authorization of the Every Student Succeeds Act (ESSA) which require schools to meet growth requirements and report the status of progress of ELLs towards learning English according to the English proficiency standards aligned to with academic standards. For science, that is the ability

to engage in scientific discourse as discussed previously (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 2014). The current testing practices that happen with ELLs are not effective in eliminating the gaps in English proficiency and thus, the language of testing negatively affects the performance of ELL students on standardized tests. The way that students from various backgrounds and linguistic capabilities are to be assessed cannot be done effectively or equitably through standardized high-stakes testing (Au, 2017). According to Au (2017), high stakes testing goes against equitable education because of the limiting of the curriculum, therefore, hindering the teacher from having the opportunity to meet the social, cultural needs of students to incorporate their funds of knowledge into the curriculum, limiting the curriculum limits a teacher's ability to engage in culturally relevant pedagogy.

Cultural relevant pedagogy is essential to engaging and making content accessible to all students (Ladson-Billings, 1995). Culturally relevant pedagogy shows appreciation to a student's funds of knowledge as assets to their work in the classroom. According to González, Moll, and Amanti (2005), teachers have to take on the role of seeking out a deeper understanding of their students and communities represented at the school. Inquiring and researching students' backgrounds and connections to the community cause teachers to develop an awareness of the resources that can be used within the classroom to better connect with the existing forms of knowledge or funds of knowledge that students already possess (McIntyre, Rosebery, & González, 2001). According to Ladson-Billings (1995), academic success, cultural competence, and sociopolitical consciousness are the keys to having culturally relevant pedagogy.

By incorporating students' funds of knowledge, students can organize content for their personal lives. A study done by Olitsky et al. (2010) showed that students did not achieve at high levels and identify with school science although they were both interested in and knowledgeable about science. The overall findings of this study support shifting towards perspectives on classrooms as communities of practice rather than as spaces for competitive displays, such as high achievements on test scores. Foundational studies done by Moje and colleagues (2004) as well as Moll and colleagues (1992) also show how using funds of knowledge in the classroom setting can help to transform the science curriculum to reach high levels of Banks' multicultural approaches. Banks' multicultural approaches integrate ethnic content into the curriculum beyond just contributing the mention of certain ethnic holidays. The goal of Banks multicultural approaches (Banks, 1989) is for teacher to transform the curriculum to be inclusive of the various ethnic and cultural perspectives of their students. These perspectives view learning as socially situated and view students as valued contributors rather than just recipients of knowledge. The study suggests that viewing students as valued contributors to the curriculum is essential in addressing the norms perpetuated in schools' hidden curriculum. The hidden curriculum of high stakes standardized testing sends the message that only a particular type of cultural knowledge is relevant in the classroom, and students' personal lives are not relevant concerning their education. Therefore, the students' prior knowledge, which is beneficial for the creation of equitable learning space within the classroom, does not have a space in which it can operate in alignment with the curriculum. Equitable learning spaces allow the whole student to be a part of their learning, not just the most comfortable parts to teach.

Creating Equitable Learning Spaces in a Science Classroom

Creating and facilitating equitable learning spaces in a classroom is essential to creating the opportunity for students to engage with content by making a welcoming space that is open to learning new information. Equitable learning spaces are not found just in the content that is taught in the classroom, but mostly in the environment inside of the classroom. Creating a welcoming environment welcomes differences and starts at the front door of the classroom when teachers greet students by the correct pronunciation of their names. Just pronouncing a student's name correctly lets them know they mean that much to you that you would take the time to learn how to say their name correctly, and not give up and give them an unwanted "nickname" (Cooper et al, 2017). Students that are ELL would benefit from a teacher learning to say their name correctly because now you can call them by name, whether it is to praise the student or redirect them. Interactions such as those mentioned previously are beneficial to any classroom learning environment, but especially that of ELLs. Even though pronouncing a student's name has not been explicitly saying in the literature to have significant benefits to the classroom learning environment, the literature does say that teachers have to construct safe classroom communities and effectively implement instructional strategies impact ELL's view of themselves as learners and their science achievement (Carlone, Haun-Frank, and Webb, 2011; Lewis et al., 2012; Llosa et al., 2016). Although not said explicitly, it should be obvious that learning a student's name so that you can identify them correctly and appropriately is a part of creating a safe classroom learning environment.

Creating an equitable learning space can also be compared to the act of creating counter spaces. Counter spaces promote the psychological well-being of individuals who experience oppression (Case & Hunter, 2012). They are meant to enhance the well-being of the individual by

challenging the current deficit thinking that surrounds a particular subject. ELL students are a student group that would benefit from having counter spaces in their classrooms because according to Solórzano and colleagues' (2000) definition of counter spaces they are places where the deficit notions of people of color can be challenged in a favorable climate, and this should be established and maintained by the teacher. From the literature of Solórzano and colleagues (2000) along with Case & Hunter (2012) ELL classrooms that serve as a counter space are equipped with a teacher who creates a classroom learning environment and curriculum that confirms the experiences of the students and unapologetically aligns the classroom environments and learning experiences with the lived realities of their students.

Another example of creating equitable learning spaces was found with a study on a cross-cultural science unit titled "Maintaining Health," which was used to teach students about what happens to their bodies when they get sick (Herbert, 2008). The author crafted the study to see how students-built bridges between traditional practices, beliefs, and western science concepts. The lessons that students were engaged in happened for one session per week for eight weeks, and the sessions were for 90 minutes. During the study the students used "street science" (George, 1986) as a springboard to build bridges to conventional science concepts. Street science was the term given to describe the traditional customs and beliefs of the participants. The study found that there was a lot of parallel collateral learning and dependent collateral learning in students' responses to prompts about how the common cold works. Jedge (1995) describes parallel collateral learning to be an accommodative mechanism for the conceptual resolution of potentially conflicting ideas. The collateral learning model is parallel with the view as science learning as "border crossing" (Giroux, 1993), which means accessing and incorporating various ways of knowing and working across those variations. Aikenhead (1997) states that those who adopt the

collateral learning model view science learning as autonomous acculturation. Autonomous acculturation honors the student's prior knowledge simultaneously, and the student can also benefit by accessing the cultural capital of western science in their own ways. This idea of collateral learning is a way of creating an equitable learning space. Only because it allows conflicting ideas to exist and be discussed so they can be put into context with the autonomy of the student standing firmly in place.

There cannot be a conversation about creating equitable learning spaces in a science classroom without mentioning how the teacher plays a role as an agent of socialization. Fillmore & Snow (2000) define socialization as the way people communicate the cultures of their communities. This socialization starts at home, and this socialization is built upon at school when the cultures match because there is a general funds of knowledge that are shared within similar cultures. However, when the cultures of home and school do not match, there is a disconnect between teacher and student. For example, for some Hispanic communities, it is a sign of disrespect for children to look at adults in the eye when they talk to them. Some teachers can take action of not making eye contact as a form of disruption (Clauss-Ehlers, 2007). This mismatch of cultures between home and school can affect the teacher’s ability to understand ELL students, assess their abilities, and teach them equitably (Fillmore & Snow, 2000). When teachers are not able to teach equitably, they are also incapable of creating an equitable learning space in their classrooms. Teachers and other stakeholders in education have to be aware of the crucial role the families and home practices play in the transition of students into the classroom.

There are unique learning needs for ELL students in a science classroom. Throughout the literature, there has been a pattern of saying that to help ELLs' learning environment, their culture needs to be infused into their learning environment, so this should be a part of the daily

learning environments (González et al., 2005). Fostering a learning environment for ELLs can be done when intentionally creating equitable learning spaces within the classroom learning environment.

Science education researchers, such as Lee and Buxton (2008), believe that there should be more attention paid to how learning is supported for the youth of non-dominant backgrounds by including their cultural knowledge and resources into their science learning. According to these scholars, for science instruction to be valid for all students, educators must identify and build on intellectual resources in learning science even when those resources can seem as if they have a disconnection with the science content learned at school (Lee & Buxton, 2010). Effective science instruction has to consider student's prior knowledge, their experiences and beliefs and evaluates how these funds of knowledge are positioned within the norms of school science so that science can be made more accessible and most importantly relevant to all student (Cobern & Aikenhead, 1998; Lee, 2002; Warren et al., 2001). When thinking about the need to create equitable learning spaces in science, it is important to understand the different types of information within science. Most of the modalities of science are elements of Western thinking and values; therefore students that are from culturally and linguistically diverse backgrounds bring a different knowledge base into the classroom that is competing with the dominant knowledge base of an American classroom (Brown, 2017; Moje et al., 2004). The funds of knowledge students have, are aligned with their identity, and students should not have to lose their identity to engage in the discourse of science.

As Lave and Wenger (1991) stated, there is a link between learning and identity formation. Carlone and Johnson (2007) conducted an identity study where they found three interrelated factors of identity: recognition, competence, and performance. Recognition is one of the

factors that found to have the most influence on science identity. A person with a strong science identity can be competent in scientific knowledge, demonstrate competence through performance, and be recognized by themselves and their peers as a science person. This study is critical because the participants were not able to formulate their own science identity, but instead, their identities were already constructed by others based on the socio-cultural legacies represented in science (Carlone & Johnson, 2007). The findings in this study can be compared to how opinions of abilities are already formulated for diverse students before they even enter the classroom. Allowing students to build their own identity and understanding how science fits in their world apart is of creating an equitable learning space in science. Teachers have a key role in the identity formation of students in the classroom because when looking at the recognition part of identity, the teacher is responsible for creating opportunities so that ELL students have regular access to share their ideas and are positioned having recognition as competent classroom community members (Yoon, 2008).

The learning of science for minority populations has as much to do with learning how to cross boundaries as it is about learning scientific content (Aikenhead &Jegede,1999). Crossing borders for students in science education involves the learners being able to harmonize their life culture with science instruction. However, science instruction usually disrupts students' worldview by forcing them to abandon their views and assimilate to a new way of conceptualizing (Aikenhead & Jegede, 1999). By disrupting a student's way of knowing by forcing foreign knowledge on them limits their ability to form any sort of identity or connection with science. For most English language learners (ELL) to continue to cross borders learning science content, they have to understand and practice trans-languaging. Trans-languaging emphasizes the language processing that happens when students are making the connections between curriculum,

home life, and cultural norms, and allows students to have space to create new identities and ideologies and overall expose students to different ways of thinking. (Cervantes-Soon & Carrillo, 2016). One of the focuses of translanguaging is to disrupt ideologies of monolingualism and linguistic purism that is the dominant discourse in language pedagogy and language education policies, such as English only classrooms. Translanguaging fosters an environment to emerge new identities and do things such as code switch and allows students to forge new ways of communicating that look and sound different in comparison to the dominant discourse found in educational settings (Garcia & Leiva, 2014).

Big "D" discourses, as have been mentioned before, are ways of knowing, doing, talking, interacting, valuing, reading, writing, and how one feels they are represented socially and culturally (Gee, 1996). Discourses are perceived as a students' reflection of their identities (Chandler, 2009). Equitable learning spaces are a necessary classroom framework that builds an environment that invites the use of traditionally marginalized funds of knowledge and discourses in coordination with academic funds of knowledge and discourses. One way that an equitable learning space in science can occur is through the idea of third space or hybrid space. Moje and colleagues (2004) refer to three views that come together to create the hybrid or third space. The three views include: 1) hybrid space as a supportive scaffold for linking marginalized funds of knowledge and academic Discourse; 2) hybrid space as a navigational space to gain competency and to negotiate difference community discourses; and 3) hybrid space that expands the boundaries of the official school Discourse. The creation of hybrid or third space is one of the most used examples of creating equitable spaces in science. Third space or hybrid space offers ways of un-

derstanding how the learning of science involves learning to negotiate different avenues of information and Discourses within a community as students are learning about appropriate academic content (Barton & Tan, 2009).

In a study done by Calabrese Barton & Tan (2008), they showed how a middle school teacher Mr. M created a hybrid space in his classroom with his students while working through a food unit. Mr. M made physical, political, and pedagogical changes to create a hybrid space within his classroom that allowed his students not to have a barrier between science and the world. Physical changes were made to the classroom during the nutritional unit to resemble the physical spaces students were familiar with in their community. Political changes happened to the government of the classroom; students were positioned with more authority. Finally, pedagogical changes happened to insure there was more overlap between school science Discourse and the nontraditional Discourse possessed by students. For example, for the lesson on nutrition there were co-planning sessions between students and Mr.M, the students were able to change and exhibit change in the way the unit was done and produced. The lessons were able to focus first on relevance and applicability while incorporating school science content knowledge (Barton & Tan, 2008). Students learned to engage in competent and meaningful scientific literacy while applying their prior knowledge of their local communities. It is important to note that while Mr. M said that lessons enacting hybrid spaces are beneficial to his students and their learning, they are just not practical to happen every day and charges other educators to identify more teaching practices that foster the creation of hybrid spaces but in a more practical way. The creating of hybrid spaces is always viewed as political and of high risk for those whose knowledge is seen as non-dominant. Hybrid spaces are seen as political, because it creates spaces

for students to author new identities, drawing from non- traditional funds of knowledge to renegotiate the boundaries of their participation in ways that help them to build their social identity and help them to establish their ways of thinking and knowing. For example, a study by Calabrese Barton, Tan, & Rivet (2008) involving engaging middle school girls in school science showed how, through creating hybrid spaces, the girls in the study were able to legitimize their commonly marginalized outside of school and home resources and capital in science to create access through the activation of their resources to science. Equitable learning spaces are different from hybrid spaces because equitable learning spaces are more focused on providing access to content for students so they can have an opportunity to understand the content and see where it fits in their lives. Hybrid spaces take equitable spaces a bit further breaks down the cognitive barriers that separate school science from student communities.

Youth often take up knowledge, resources, and identities that do not always have a place in school and creating a hybrid space allows for navigating space for a smooth transition between the students' lives and the science classroom. Hybrid space in any classroom gives the learner epistemological authority within the curriculum they are learning (Barton & Tan, 2009). Creating hybrid spaces in classrooms enacts restorative justice because the hybrid space respects all knowledge as relevant and gives room to interpret the Discourse of students and even the teacher through conversations and dialogue in the classroom (Winn, 2018). While Winn (2018) uses restorative justice to discuss the paradigm shift that needs to happen in how students are administered punishment, I used restorative justice to explain how teachers and other stakeholders should use hybrid spaces to restore justice to marginalized students by making the learning process equitable thus creating equitable learning spaces.

Teachers, Teachers, Teachers, and What We Need from Them and What They Need from Other Educational Stakeholders

A clear theme throughout this literature review was that teachers are a crucial entity in creating equitable spaces in the classroom. According to the NGSS, teachers are responsible for engaging students in the scientific and engineering practices woven throughout the standards (NGSS Lead States, 2013). To most teachers that complete teacher education programs, the methods course for teaching science content does not take into account how to teach students the Discourses of science, and not often is there an opportunity to learn about how to teach ELL students the discourses of science. According to Cochran-Smith et al. (2016), teacher education programs in the United States do not adequately consider that in the 21st century, most classrooms will have students whose first language is not English. Furthermore, most teachers that work with immigrant and limited English proficient students lack the foundation to understand the mismatched Discourses of their students (Valencia, 2010). How can the issue of not having the culturally informed teacher force needed to help ELL students succeed be fixed? Tolbert et al. (2014) states most teacher education programs do not provide such preparation that integrates rigorous science instruction with the development of English Language and literacy. Effective teachers are essential to meeting the needs of diverse learners and critical in preparing these learners for the 21st century (Garcia et al. 2010). Few models exist for teachers in teacher education programs that teach teachers how to promote scientific discourse practices or engage students in a rigorous learning experience in a linguistically diverse science classroom (Trent et al., 2008). Studies done by Buxton et al., (2015) created a professional development opportunity for teachers to have pedagogical models to facilitate the development of language and scientific practices, and a supportive teacher network for the implementation of the Language-rich Inquiry

Science with English Language Learners (LISSELL) pedagogical skills. The study found that engaging teachers in professional development that modeled practices helpful to the implementation of LISSELL, the current fidelity professional development model limits professional learning for teachers. The fidelity model of professional development requires that participants adopt assumptions about the path of professional learning to classroom practice. This model positions teachers and students as passive objects of teaching and learning instead of agents of change (Buxton et al, 2015). Instead of using the fidelity model, the study used practice theory to provide more of a nuanced examination of how local meanings of successful science teaching to bilingual learners were constructed within and against the broader structural forces such as current policy, financial constraints, and evolving standards.

ELL and diverse students are more vulnerable in classrooms where teachers are not equipped with these skills because they are the largest group not to have qualified or experienced science teachers (Stoddart et al., 2010). Teachers not having teacher education programs that prepare them to teach diverse learners hinder teachers from creating equitable learning spaces for their students because they cannot make the content accessible for all learners.

Secondary science teachers are generally thought to be teachers of content and not necessarily language. However, the overt focus on language-intensive science and engineering practices in the NGSS necessitates teachers consider the role of language in their classrooms. Integrating intensive language demands into already complex science teaching is already difficult for teachers, but even harder to navigate when educational stakeholders such as teacher education programs and professional development do not provide such preparation. Teaching science con-

tent and multicultural education are taught as silos from each other in teacher education programs (Trent et al., 2008). So, this means they are not necessarily taught to have a symbiotic relationship with one another.

According to Francis & Stevens (2018), teachers are better prepared to work with ELL students in science classrooms when they have preservice preparation that examines teacher perceptions of their cultural and linguistic background, and have field and community-based experiences, and learning of how to teach disciplinary content and disciplinary language. Teachers serve as a gatekeeper, so their ability to put the value on their students' funds of knowledge and incorporate them into the classroom learning environment is essential.

In-service teachers need similar content but in a different way. One of the common mechanisms to address the needs for teachers to effectively teach and support ELLs in science learning is professional development. In-service teachers want professional development that builds on research-based practices. Often teachers have to engage in the one-stop-shop professional developments that are one-time workshops that have limited to no follow-up (Ball, 2009). Studies show that when ELL teachers have more opportunities for meaningful professional development early in their teaching career, they are more effective as teachers of ELLs (Boyd et al., 2009; Master et al., 2016). Francis and Stevens (2018) point out that despite the growing awareness of ELLs and the assets they bring to the classroom, there are still teachers that hold a deficient perspective of the assets of their ELL students and their ability to learn science content. Teachers that are effective with teaching underrepresented students, such as ELLs, share specific characteristics, including the ability to teacher culturally sustaining pedagogy (Paris & Alim, 2014). If teacher education programs in and out of the physical public-school building can teach educators how to develop and engage their students in culturally sustaining pedagogy, this will help

advance equity in the classroom, especially for science (Paris, 2012). The blame for the lack of equity in the science classroom cannot be put solely on the teacher or other stakeholders in education. It takes a village to teach a child. It is up to all stakeholders to be reflexive in their role in creating equitable spaces in the classroom so they can see its importance in creating academic access to all students.

Significant Findings of the Literature

Based on this literature review, a secondary science teacher would have issues finding examples and models of exemplar science teaching for ELL and other diverse students within the body of research that is currently available. Studies done by researchers like Barton & Tan, (2009) point out how specific strategies were used in primary and middle grades classroom, but there is not an abundance of literature on incorporating equitable learning spaces such as hybrid spaces in the high school science classroom. Having more models of secondary science strategies for ELL learners would be more helpful for teachers that have to deal with all of the pressures with science teaching in the environment of high stakes testing and standardized curriculum. Lastly, another major trending issue throughout all of the research was the lack of teacher self-efficacy in terms of integrating language into science content (Tolbert et al. 2014). Creating equitable learning spaces such as hybrid spaces in a science classroom will provide the learning opportunities needed to incorporate language into the content so that it does not seem like a daunting task to overcome (Rahm 2008). Equitable learning spaces are essential for ELL learners and diverse learners alike. There are already so many barriers that can hinder the learning for CLD learners, so creating equitable learning spaces at least creates an environment that creates spaces for students to work through their barriers so they can gain access to scientific and other academic content.

How the Literature Informs the Research

Overall, conducting this literature review of the NGSS and the ways that are most beneficial for ELL students to learn science contributed to how I framed interview questions that were used to record the journey of other ELL and diverse student teachers as they examined how they create equitable spaces in their science classrooms. Also, I wanted to craft a framework that was an adaptation of the existing framework called the Growing Awareness Inventory or GAIn (Brown & Krippen, 2016). The GAIn was designed to identify and incorporate students' cultural and linguistic backgrounds into reform-based instruction. This tool was of interest to me because of how it was geared to find instances of culturally responsive pedagogy in reformed-based instruction because that is what I dealt with in my classroom every day. The GAIn was based on these tenets a. every classroom contains diverse students that have culture (Erickson, 1996) b. students' cultural and linguistic backgrounds are demonstrated in observable ways (Gay, 2010) and c. those backgrounds are expressed in ways that preservice teachers are capable of observing. I wanted to take the GAIn structured protocol and amend it to be used for in-service teacher classroom observations and include within it the ability to identify classroom learning environment characteristics that create equitable learning opportunities. I thought this protocol should be used not only by preservice teachers but also by all educators that want to go into classrooms to make observations that believe in social justice.

With further research, there is a need to produce further studies that give insight as to how to foster equitable learning spaces for diverse and ELL students in a high school science classroom.

High school can prove to be a time where there is more pressure put on a student to pass so that they can graduate. During this time, ELL students must be given equitable resources during their academic career to make sure they can gain access to education and thus close the achievement gap. Achieving the goals previously mentioned cannot be done if ELL students are put into classrooms that are not equipped with equitable learning opportunities that allow the students to achieve. As the research has stated, teachers want to provide these environments, but the issue is they do not know how. It was my intention as a teacher-researcher to contribute a study to the body of research on equitable learning spaces in science that can make the connections between teacher professional learning and how they influenced teachers crafting equitable learning spaces in their classroom. I also wanted to create a framework that gave teachers more guidance on how to create equitable learning spaces in science and hopefully give them self-efficacy to facilitate these learning spaces filled with equity in their classrooms.

3 METHODOLOGY

This chapter presents guiding epistemological assumptions, an overview of a case study as a methodology, participant and site selection, data collection, data analysis, and a statement of positionality.

Epistemological Framework of the Researcher

The critical epistemological framework informed this study. The critical paradigm addresses the political aspects of teacher understandings when creating equitable learning spaces within their classroom and curriculum. In the critical paradigm, meaning and reality serve higher political means. This paradigm is grounded in realism and holds to a sense of power and agency (Harvey, 2002). The critical paradigm has roots in the interpretivism but adds a "What now?" indication in identifying and discussing problems involved with research. This research study explored teacher understandings and how they influenced the creation of equitable learning spaces within the science classroom.

Interpretivists see reality as a social construction, which means there are multiple realities. The interpretivist research lens coincides with the idea that teachers own social construction and reality can influence how they organize student learning environments and their importance when teaching students curriculum. Multiple realities exist, and these realities shape a person's way of knowing the world. A critical theorist viewpoint draws out a "restless consciousness" that in turn, added depth to the research study(Crotty, 1998).

Interpretivism looks for culturally derived and historically situated interpretations of the social life-world (Crotty, 1998). The critical paradigm applied the problem-solving element to

research and considered the multiple realities of teachers that have been a part of different types of teacher education and have various cultural backgrounds and knowledge interpretations. Interpretivists acknowledge that students who participate in science education have multiple realities, and the science curriculum may or may not be welcoming of their cultural background. Teachers have to consider their students' culture when planning curricular activities to facilitate an equitable learning space. To better understand the "so what" factor of creating equitable learning spaces in our current school climate, there was further investigation into the beliefs and multiple realities of teachers that are tasked with creating equitable learning spaces for students. It was essential to understand how the interpretation of knowledge and learning from their teacher professional learning and life experiences impact teacher decision-making and create equitable learning spaces within their classroom. A critical paradigm helped the researcher to explore the topic of teachers and how they created equitable learning spaces through methodologies, such as case studies.

Case Studies as a Methodology

I aligned my chosen methodology of case study more with conceptualizations advanced by Merriam (1998). Merriam characterizes a case study as a unit around which boundaries are held and can be a person, program, or in my case, a collection of teachers. The researcher used Merriam's definition of case study because of the emphasis that Merriam puts on qualitative data collection methods to gather data from the participants in the study. The researcher chose Merriam's (1998) approach to a case study because of how the data is used to create categories to conceptualize different approaches to doing one task. Merriam acknowledges the multiple realities that exist and also uses common language to make case study research more accessible to non-researchers. Case studies allowed the researcher to explore the different factors people use to

operate within these bounded systems. According to Merriam (Yazan, 2015), case studies should be approached from a constructivist epistemological viewpoint to make sure the reality does not get objectified. Case studies presented multiple interpretations of reality. The approach of Merriam helped me research, observe, and hear the participants' experiences using detailed, thick description as well as understand the overall dynamics of the case Merriam (1998). As mentioned above, interpretivists, too, believe that people have multiple realities, but using the lens of constructivists helped the researched engage with the participants to capture their multiple realities and how it influenced their creation of equitable learning spaces.

Teachers represent a cornucopia of different perspectives on how the world works, creating diversity in pedagogical decisions in curriculum and instruction. Case studies were a helpful approach in exploring various classrooms where teachers attempted to facilitate equitable science instruction. Case studies reject a single reality and acknowledge the multiple realities that operate within a situation. The framework of case studies is indicative of the constructivist point of view because it is rooted in the belief that society is constructed from relationships with one another (Hagedorn, 1983). Case studies offered a means to explore complex social environments with multiple variables of importance to understand the system studied (Merriam, 1998, p.41).

Data

Qualitative data consists of direct quotations from participants' observations that give others insight into their experiences, feelings, and knowledge (Merriam, 1998; Patton, 1990). This information is usually recorded through interviews, observations, and documents that give detailed descriptions of people's actions and behaviors. Merriam uses the most common data collection methods in her research through interviews, observations, and documents. The researcher

of this study used those data collection methods to answer the research questions. Wilcott (1992) posits that collecting data is about asking, watching, and reviewing. This author also highlights how data collection is a strange concept because data is not just out in the world waiting to be collected but has to be first noticed by the researchers to be treated as data apart of their study. One challenge in collecting these qualitative data sources is keeping track of all the various types of information. The researcher was mindful that it was essential to develop a system to track the different data sources to triangulate the data to systematically check the information collected from one source to compare it to another (Gagnon, 2010).

Data Analysis of Case Studies

Data analysis is an ongoing process that happens concurrently with the data collection process. This ongoing data analysis allowed the researcher to go back and forth between the data and data analysis to work towards the development of insights that helped refine data collection to enhance the focus of the study and the authenticity of the accounts being developed (De Weerd-Nederhof 2001; Miles and Huberman 1994). When analyzing data within a case study, the researcher went back through the data several times to ensure that the correct interpretations were drawn without unexplained anomalies (Cohen et al., 2017). After purging unnecessary details, coding was made easier to analyze and identify units that related directly to the phenomenon of interest. Merriam (1998) characterizes coding as assigning a shorthand designation to different aspects of data to organize the data to find and easily retrieve specific pieces of the data. There are two levels of coding, identifying information about the data and also the interpretive constructs related to analysis. Merriam highlights how it is important to code according to whatever scheme is relevant to the research study. When the researcher concluded coded they them used the codes to find themes within the data received from the study. Braun and Clark (2006)

characterize using themes as a thematic analysis, because the researcher is identifying, analysis, organizing, describing and reporting the themes found within a data set.

One of the ways that data was analyzed according to Merriam was by using content analysis. Content analysis is used to explore the meaning of written, verbal, or visual communication messages (Cole, 1988). According to Hsieh and Shannon (2005) to analyze data using content analysis methods, the researcher needs to simultaneously code raw data and construct categories that capture the content's relevant characteristics. First the researcher analyzes the data by reading all data repeatedly to achieve immersion and obtain the general picture of the data. Then data is read again to gather exact words from the text that appear to capture key thoughts or concepts. Next, the researcher went back through the data again to make notes of the researcher's initial impressions, thoughts, and initial analysis. As the process of content analysis progresses codes emerge that come directly from the text. Codes are sorted into categories and used to find meaningful clusters.

Reflexivity

The researcher has to balance their subjectivities with their descriptions of events and cultures within qualitative research (Austen & Sutton, 2014). The author can do this by being reflexive. Reflexivity causes a researcher to do constant checking and balancing with themselves concerning the study. Researchers need to find the balance between their personal feelings and emotions not to be intertwined with the data they are collecting. Every researcher brings their characteristics to studies, and they should be acknowledged. Researchers should always be aware of how their subjectivities influence their research and how they could affect the research frame. Researchers have to be reflexive during qualitative research to not let their own biases influence

and alter their data findings. While conducting research, the researcher avoided creating isolated depictions of situations within the data because doing ignored the event's overall structure (Denscombe, 2014). According to Cooley's (1902) notion of 'looking glass self,' researchers should deliberately acknowledge and question their subjectivities throughout their research. This questioning forces the researcher to understand their part and their influence on the research.

Proposed Study

This study was conducted using case study qualitative methods involving thematic analysis. The case for this study was defined as science teachers who teach English language learners and other diverse learners in science classes where there were students who have a primary home language other than English (PHLOTE).

Research Question

This study examined how science teachers created equitable learning spaces and experiences within their classrooms for English language learners and other diverse learners and how these decisions to facilitate equitable learning environments and experiences supported their students' learning.

1. In what ways did science teachers conceptualize equitable learning spaces and experiences within their classrooms for English language learners and other diverse learners?

Context of the Study

The study was conducted at one high school located in a metropolitan area school district in the southeastern United States. At this school, a significant number of students had a Primary Home Language other than English (PHLOTE) about 51% and a large population of ELL students. The school demographics for school was Hispanics 48%, African American 28.5%, Asian 6.5%, White 14.2%, and several other ethnicities. This school's composition was predominately White 5- 10 years ago but changed drastically within the last few years (Public School Review, 2018). This high school was chosen because of its diverse demographics and the amount of students who are both English language learners and also the large number of students who possess a diverse cultural background. This school was also chosen because the teaching staff is 85% white and this number matched the demographics of teachers in the rest of the United States.

The study was done in general education science classes and sheltered or English language learner only science classes. General education science classes referred to science classes that do not directly serve sheltered English language learners but still have ELLs present in their classrooms. 'Sheltered' is the term used to identify classes where the class population is composed entirely of English language learners. Sheltered science classes were chosen for the subject and the teaching of English language learners. General education science classes were chosen, so the researcher could explore how teachers created equitable learning environments for students who were not directly served in a sheltered science class but should be monitored or closely looked after while attending general education science courses. Science subjects for the study were chosen from various academic levels like special education, college prep, advanced placement among Biology, Chemistry, Ecology and Physics courses taught. The researcher found it important to get visibility for how equitable learning spaces are created for English language

learners or students who have a PHLOTE in different levels of science classes and gain examples from educators who are doing work of this nature.

ELL students are put in Ecology if counselors or teachers assess their English as needs improvement before they are put into a vocabulary rigorous course such as Biology. Chemistry and Physics are upper-level courses that are even more difficult if students' academic English proficiency needs significant enhancement that can be accomplished by taking Ecology. The Ecology course provided students with a more relaxed learning environment to learn both academic and colloquial English in a science classroom. Students did not have to worry about standardized state or district tests to assess their knowledge of ecology. The Ecology teacher has more autonomy on students' pace and content, creating a more valuable learning space for students. Chemistry is taken in sequence after biology, and physics is taken after chemistry. Once students finish physics, they are usually given the option to take a fourth-year science course such as Forensic science, Oceanography, or Anatomy, but for most English language learners, they do not get this opportunity to choose a new science course to explore. They do not have the opportunity to choose a new science course to explore because the space in their schedule has already been taken by them having to take Ecology to help improve their English.

Participants. Criteria for participants in this study included being any teacher that is a participatory stakeholder in science education at this particular high school. A participatory stake holder is any individual that makes science curricular decisions for students. The participants in this study were high school teachers of students enrolled in 9th-12th grade biology, physics, chemistry, or ecology courses. The criteria for teachers recruited was they either taught sheltered science classes or general education classes that have students that are or were labeled as English language learners or have primary home language other than English (PHLOTE). The

teacher needed to be certified to teach science and have at least three years' experience teaching ELLs or students that have a PHLOTE. An important aspect of the criteria for teacher participants is they had genuine interest in the academic progress and the see the assets that ELL and diverse students possess. The pool of teachers that participants were chosen from what consisted of 99% white teachers, because there were only three self-identified teachers of color within the science department. The teachers of color were not in the study, because they chose not to be.

The teachers involved in the study also were chosen because of their influence in teaching English language learners in science classes, and also how they mirrored what the teacher work force is in the United States. The influence of science teachers has the power to affect their ELL and diverse students' trajectories in regard to their career paths in science or STEM (Boyd et al., 2009; Master et al., 2016). For this study, at least 6 teachers were recruited to participate in the study to gather their insight about creating equitable learning spaces in science classrooms. Teachers for the study were recruited by suggestions from English as a second or other language assistant principal, department chair, or colleagues that know of other colleagues that are doing the work of creating equitable learning spaces or experiences in their classrooms. After going through the study however one teacher was removed. This teacher was removed, because they failed to give concrete responses to interview and focus group questions that allowed the researcher to gain data.

The students of these teacher were identified as English language learners at the school in context. The grades have a range because, students' grade levels can vary in science classes, because of students own personal academic journey. For example, in a freshman biology class there could be anywhere from 9^{th} to 12^{th} grade, because students could either be taking the class for the first time as a freshman or taking it again because they failed it. The students of the teachers in

the study generally had a primary home language that is other than English (PHLOTE). The teachers of these students were selected for this research study because their students were and continue to be among the most vulnerable groups within our school systems and tend to be the students who are not always provided with equitable educational opportunities. The researcher found it very important for there to be examples in research of secondary science teachers who are creating equitable learning environments and experiences for students who have been labeled as ELL or have a PHLOTE.

The demographics of our school systems are continuing to change rapidly, and teachers and other stakeholders in education need to evolve their pedagogical tools to be welcoming of all students and cultures so that students can progress academically while not having to acculturate.

Methods

Data Collection

The sections below describe several different data sources that were collected for this study. Before all interviews and focus groups teachers were asked to bring artifacts that represent equity. Teacher participants used these artifacts during the initial interview, focus groups and also in their final interviews.

Interviews. Teachers were interviewed two times in efforts to understand their position on and understandings of creating equitable learning spaces in their science classrooms. Semi-structured interview protocols were used for each interview as seen in Appendix A. The first interview focused on the teacher's education background and their initial views on equity and how they built equitable learning spaces and experiences in their classrooms. This interview occurred

at the beginning of the study to develop a general characterization of each teacher, and to get the teachers' initial thoughts on equity. Teacher participants were asked to analyze why they think the artifact they brought represents equity.

After the two focus groups are conducted there was a second and final interview with the participants. This interview was used to discuss the major findings from their participation in the equity focus groups and from the other teacher participants. Participants were asked about how they planned on continuing their equity work in their classrooms. The conclusion interview was different from the initial interview because it sought to put everything together and allowed participants to reflect on their own curricular decisions. The researcher facilitated a conversation through a list of interview questions as found in Appendix A to help teacher participants to dig deeper into their thoughts about how equity functioned within their classroom learning environments.

Focus Groups. Focus groups were used to gather the majority of the data for the study and was a group interview where reliance was placed on the interaction between participants when a topic is supplied by the researcher (Morgan, 1988). There were two focus groups for this study. After the initial interview all teachers were given various reading materials that focus on equity.

One of the articles participants were given focuses on teachers' critical roles in creating an equitable learning environment and strategies for equitable classroom management (Hanover Research, 2017). The Hanover research article was given to teachers after the first interview as "homework" so teacher participants were ready to discuss the information in the article for the first focus group. The researcher wanted the teacher participants to read this article because the

article offered insights on how beneficial creating equitable learning spaces can be to the classroom learning environment. The article provided examples of how teachers play a role in establishing equitable environments and how to manage their classroom equitably. The researcher provided a document that maps out how to build equity in the teaching practices of educators that was adapted by Vigil (2016) & (Banks, 2015). This document was important because it gave concrete examples of how educators could integrate equity within their teaching practices.

The next two articles were selected to help to build on the teacher participants knowledge of how equity operates in a science classroom and also within school politics and decision making. A study by Carlone, H.B., Haun-Frank, J., and Webb, A. (2011) looked at how fourth grade science classes assess equity in their classroom beyond just skills that can be learned in the classroom. The last article dove into the topic of diversity and equity in science education by authors Lee, O & Buxton, C (2010). The article informed the participants about how the complicated dynamics of increasing population of ELL students, realities of standardized test scores, and the politics of accountability in education were discussed. For the first focus group participants spent time diving into their individual meanings of equity and how they operationalized equity into their science classrooms. Different elements of the articles were discussed during the first focus group as well.

The next and final focus group focused on the different ways that equitable opportunities could be created within a science classroom. Focus group two was set up like a show and tell of artifacts and experiences the teacher participants have collected that represent how they have created an equitable learning space or experience in their classroom. The researcher encouraged participants to bring both academic and classroom learning environment artifacts. The purpose of the focus groups was to provide two types of examples for readers. The researcher wanted the

focus groups to show how teachers worked towards the goal of creating equitable learning environments and experiences in their science classrooms. The second purpose was to give examples to other science teachers of how to create activities and experiences that are equitable in their own classrooms. When encouraging the teachers to bring artifacts to the focus group the researcher wanted them to focus on equitable learning experiences that foster language, connections to students lived experiences, and also assignments that promote social awareness.

Documents. Teacher participants were encouraged to bring lesson plans, assessments, and artifacts to their interviews and focus groups . These documents were used when the teacher participants were discussing how they created equitable learning spaces and experiences in their classroom. Lesson plans are essential tools used by most educators to plan out their activities for the week. Not all lesson plans look the same, so the researcher used whatever form of lesson plans the teacher offers. One crucial activity, and often carries a heavyweight for most students' grades, are classroom assessments. Classroom assessments whether formative or summative were used to examine how teachers created equitable assessment opportunities for students. One of the most useful pieces of data that was collected was the artifacts. The artifacts really showed and modeled how other science teachers can create equitable learning spaces and experiences in their classrooms.

Data Analysis

Thematic analysis was used to focus on participants' responses to the questions prompts during the focus groups and also to analyze the responses of the participants in their pre- and post-interviews to look for themes and recurring patterns of meaning of the teachers understand-

ing and their practice of creating equitable learning spaces (Braun & Clark, 2006). The participants' responses were coded in order to gather main themes of how the teacher participants create equitable learning spaces or experiences, so that these themes can be discussed and reflected on by the teacher participants during their conclusion interview.

All interviews were recorded and were transcribed and then coded using NVivo software and kept on a single flash drive at the researcher's home. Only the researcher had access to these transcriptions. After both interviews and focus groups were conducted, the researcher analyzed them to look for themes and analyze the processes and execution of the equitable learning spaces and experiences among participants. Table1 as pictured below shows how the researcher aligned the data sources and how they were used to answer research questions

Table 1.

Data Source alignment table.

Data Sources	**Interviews**	**Focus Groups**	**Documents**
Research Questions			
1) In what ways did science teachers create equitable learning spaces and experiences for diverse and English language learners?	-Interview 1 examined teachers initial thoughts on equity and how equity operated in their classrooms. Interview 2/Conclusion focused on what impacts the study had on their practices and how they planned to continue the equity work in their classroom	Focus group 1- had teachers use provided reading material to explore how equity could function in a science classroom to foster equitable learning environments for English language learners and students that have a PHLOTE. Focus group 2- was used for teachers to present examples and models of how they provided equitable learning classroom learning environments and learning experiences in their classroom.	-Artifacts were used throughout the duration of the study so that participants could exhibit how they created equitable learning spaces and illustrate their own personal feelings of equity.

Trustworthiness

To maintain trustworthiness throughout the intended research study the researcher had triangulation, member checking, and involve participants throughout all phases of research. The researcher had triangulation by having multiple sources of data such as observations, interviews, documents such as lesson plans. Member checking happened by the researcher debriefing with the teacher participants after the analysis of the data received from initial interviews and focus groups. This debriefing happened after the second focus group and before the conclusion interview. Finally, as mentioned before the researcher involved the participants in all parts of the study by allowing the teacher participants to read the case analysis that was developed from the data received from the participants. All the methods used to maintain trustworthiness were important for maintaining the internal validity during the case study. During the research study the researcher kept a reflexive journal in which the researcher documented all their feelings and subjectivities about what was observed and documented during the research study. This reflexive journal was used to keep track of the subjectivities and biases of the researcher.

Time frame

This study was conducted between 9-10 weeks. This plan allowed enough time to complete interviews and focus groups while analyzing information that was received from the focus groups to be discussed in the final interview. Table 2 as shown below illustrates how the researcher allotted time to do the data collection and analysis during the research study.

Table 2.

Time frame chart

Week 1-4	Week 5	Week 6	Week 8	Week 9-10
Recruitment, Initial interview, and dissemination of focus group reading articles	Focus group 1 how equity can operate in a classroom and important takeaways from the reading material.	Focus Group 2 What are some models and examples of how to create equitable learning environments and learning experiences in a science classroom.	Data Analysis and Debriefing of participants	Post Interview To get the further implications of their participation in the study in their classrooms.

Statement of Positionality

I am an African American, Lesbian, Scientist, Researcher, and favorite role of all Educator. I position myself as an emic concerning my research on creating equitable learning spaces in science classes. I have been on both sides of my research as the teacher and the student. I have experienced unrestricted learning not plagued by standardized tests, and I am currently experiencing being teacher who is working to create equitable learning spaces in her classroom. The schooling I received while in elementary, middle, and high school was what I reflect on being a fun learning experience. I do not remember ever being overly stressed about standardized tests or a test that could decide whether I would get promoted to the next grade level year. I remember learning about so many new things, and having a learning environment that was stress-free and

unrestricted. Once I got to high school, the way students learned and how their learning was assessed quickly started to change. I shifted from an environment where there was no such thing as standards to one where students were required to know what standard they were learning each day.

Now, as a teacher, I am on the other end of the classroom environment. I am now the teacher and content facilitator. I now have some autonomy in curricular decision making, but not as much as I would like. As a teacher in my school I am currently the only teacher of color within my curriculum group. I am in constant battle with myself over whether or not my colleagues are interpreting my ideas with understanding and are not focused on the delivery. This causes me to be reluctant to speak in meetings and nervous about reactions when I do speak up. Having to constantly feel like you have to worry about how you're going to be seen is exhausting. As an African American woman my delivery of ideas is not always cool, calm, or collected. The delivery of my ideas can sometimes be viewed as aggressive by my colleagues when I am simply being passionate about my ideas. I don't want my students to feel like this in my classroom on any place where learning should happen. I don't want them to feel silenced or misunderstood because their cultural norms are different.

I do not take the responsibility of creating welcoming and equitable learning environments lightly. Students should not feel how I feel when I attend curriculum meetings. Students should have access to equitable learning environments and teachers who confidently understand how to create equitable learning spaces. I do my best to create welcoming environments for my students whether I am in my science classroom or in the hallway. I hope they feel that when they see me in or out of the classroom they are important, and that I see them as a total person. I know what it's like to be minoritized every day and I don't want my students in my classroom to

have those feelings of less than. My personal journey to learning about what equitable learning environments has been a very eye-opening journey. As I learn new things throughout my research I challenge myself to adapt my thinking and my practices in and out of my classroom.

Creating an equitable learning space comes natural to me as an educator because of my identity as an African American lesbian woman. I have witnessed how my identity operates in different spaces such as the media and within educational institutions, and how they are often times viewed from a deficit mindset. As a teacher I have also witnessed how the diverse and multicultural identities of students can operate in the classroom also from a deficit. The wonderfulness students bring to class every day is an asset not a deficit to the learning environment. Creating equitable learning spaces uses the assets of students and incorporates them into curricular decision making and their classroom learning environment.

I do not see my students as just children in my room I see them as complete persons. Complete persons with different personalities, learning styles, cultural experiences, and feelings. As a teacher of English language learners, I have an insight into how creating equitable learning opportunities can be challenging, especially when teachers have to keep up with unrealistic pacing calendars that do not consider language and cultural barriers to learning that ELLs and other culturally diverse students have. My research provided insight to how teachers create equitable learning spaces in science classrooms, especially in our current educational climate that includes traumatic racial inequality and a global pandemic. When I attended high school it was a place that I felt recognized and did not feel like the curriculum did not have a spot for me. I felt a sense of place in high school. The sense of belonging or place can be credited to the teachers I had that looked like me and created spaces for me to learn about different possibilities. I had teachers that

took the opportunity to learn about me and what I did outside of school, or even just paid attention when I got a new hair style. I hope my research is able to show teachers how creating an equitable learning space can be done and also how we can go about making curricular decisions equitably.

Unfortunately, every student does not get the opportunity to be in a classroom where their teacher facilitates an equitable classroom learning environment that shows students the future possibilities. My research on equitable learning spaces will help to provide resources and thoughtful examples for other teachers and hopefully foster conversations on what creating equitable spaces are. In the school in context there is a sizeable population of students who are English language learners along with a teacher population that is 85% white. As a researcher I want to investigate how teachers in this school go about providing equitable learning environments and opportunities for the English language learner population along with students that have a primary home language other than English (PHLOTE) in science classes. It is my hope that my findings are be beneficial to the learner population of teachers that would like to know more about equitable learning spaces and how to create them in a science classroom.

Boundaries of the study

Case studies are sound methodologies because they show relationships between abstract beliefs and knowledge, but they also have boundaries, just like any other methodology. There were mainly four limitations (McLeod, 2019) point out. Case studies cannot be generalizable because every reader might not understand their application. This methodology was not be readily open to cross-checking because of other researchers' subjectivities and how they might affect the data. Case studies are difficult to duplicate, and they can also be very time consuming.

Further, the world was going through a pandemic. Covid-19 created many boundaries for the research, such as not having face-to-face classroom observations and doing personal interviews through digital meeting platforms. However, as the researcher, I did my best to gather intrapersonal information from the participants of my study to gain data to build my case.

4 FINDINGS AND DATA ANAYLSIS

This chapter begins with summarizing the demographics of the teachers participating in the study and continues with a discussion about how the teacher participants conceptualized how they created an equitable classroom learning environment for science classrooms through space and curriculum.

Summary of Participants

For the study there were initially a total of six participants, but the sixth one was removed from the case study after it was determined that their interview and focus groups responses did not render that much data. Out of the five cases that were used for the study four were female and one was male. All participants were white. The years of teachers ranged from three years to 24. Below the reader will find the cases that were written for each participant and then a cross case analysis that looks at the major themes that can be gathered from all the participants.

Grace

Grace has been an educator for almost 14 years. She began her career as a middle school science teacher but recently transitioned to high school. Grace taught all-sheltered students labeled English language learners (ELL) schedules of chemistry and physics in this school year. All-sheltered means that Grace teaches English language learners all day. Previously she taught college preparatory or on-level chemistry and physics. She completed a teacher preparation program at a large research university where she recalled learning about gender equity as the only type of equity addressed during her program. In her program, they discussed gender equity through an activity called "draw a scientist." During her initial interview, she also discussed how she did not have any significant learning opportunities to explore equitable practices in a science

classroom and that she mostly just tried to figure things out on her own. When asked during her first interview what her definition of equity was, she stated, "Equity for me would be giving everyone an equal opportunity." Throughout her interviews and focus groups, the following themes emerged from her contributions: Overcoming obstacles for a successful future, creating equity through non-monolingual environments, and Teachers operating as a collective.

Overcoming Obstacles for a Successful Future. The students that Grace teaches came from various backgrounds, ethnicities, and cultures. Backgrounds are not obstacles that need to be overcame for students (Fillmore & Snow, 2000). These obstacles could be language barriers or cultural ones. Grace wanted to create a space where these obstacles did not keep her students from being successful and help them learn how to navigate through those obstacles. One way Grace built equity in her classroom for her ELL students was to put a recording of her lesson on her digital platform every day. Grace stated that:

> "So, every single day, I put my recording of my class on eclass, the digital platform, just for them, so that they can go back and watch it. Um, so again, I know, that is a little thing that we probably all do." [FG2]

Grace was assigned a student-teacher to come and study under her for the semester during this school year. The student-teacher gave students a class survey for one of their communication courses, which was anonymous. It was through this survey that both teachers learned how beneficial putting the class recording on a digital platform was for students. Grace used the information learned from her student teacher's surveys and included it in her classroom decisions to make her curriculum more equitable. During the second focus group, she said:

> "She surveyed my kids, and several of them talked about how much they appreciated, especially as our kids being able to go back and watch the video, if being in class was like, going too fast, or if they were distracted, or they needed to hear it again." [FG2]

By Grace posting videos to make the classroom lesson more accessible for her students, she created an equitable space. She only started doing this during the COVID-19 pandemic because she was a concurrent teacher, teaching students in her classroom and students on zoom. Grace said during the second focus group that putting a recording up of her class was "a very intentional way to have some equity in the classroom, and not for just students that had to work during class, but for all her students" [I2].

During Grace's interview, she also talked about the book *Becoming* by Michelle Obama. Through reading this book, she realized how education is like a system of ropes and ladders that lead to the sky, which can be invisible for some people. However, "For some people, it's not. Some people get to the point where they can see it; they can grasp it." Grace talked about how as a student and even as an adult, she was able to "sit down and find a way to do the things that I wanted to do or find a way to do the things that I wanted to accomplish." Grace called this type of ability to have a seat at the table or "way to the sky." Grace said that "every student should have the opportunity not only to see the path but to be able to start to grasp it." Allowing her students to have a seat at the table is why she made sure to create paths for her students to overcome certain obstacles to learning through equity and creating multiple pathways to learning in her classroom. Grace mentioned that some of the obstacles to learning students have to make their way through would be standardized testing, not being accustomed to learning environments, and having a cultural mismatch than what is found in schools.

Grace helps her students overcome obstacles by creating a safe space for students to build their confidence to help them to be successful in their future. For example, helping her students get comfortable with reading aloud in preparation for standardized tests like the ACCESS test that ELL students have to take every year to measure their levels of reading, writing, speaking, and listening of English.

> "I know, like teaching sheltered, sometimes it feels babyish when we read out loud, but I tell them, I set it up, like, 'Hey, I know you got to take the ACCESS, I know, we need to practice our speaking and oh, we need to practice our listening, I know, we need to practice our reading. And so we are gonna read out loud. And if you stumble over a word, I'm gonna give you a second to try again, and then I'll help you out." [FG]

During the focus group and interviews Grace spoke in more detail about how to help students to overcome the obstacle of standardized testing. She really didn't go into much detail about how she would help students overcome not understanding "school" and cultural mismatch that what is found in schools. The last two obstacles are obstacles she agreed with that were mentioned by other participants.

Grace knows that multilingual students having confidence in their voice helps them be more open to participating in class and not being silent. Grace knows that students have to be comfortable to create an equitable classroom so that they can make mistakes and teachers can support them in overcoming those mistakes and get better. Grace provides room for voice and comfortable mistakes by creating a safe space for her students.

One of the things mentioned throughout Grace's interviews and during focus groups was the importance of creating a safe space for her students. She believes that to create equity teach-

ers have to make sure your students feel comfortable and safe first within their learning environments. Relationships have to be built in order to create a safe space with students. Grace said, "The first thing is that students have to feel safe to share who they really are, there has to be time spent really developing those relationships to help them feel comfortable and building trust." [I1] Building relationships takes time and to do this and Grace spends time talking to students and learning from them. Grace stated, "There has to be a lot of one-on-one conversations and a lot of listening and learning. Asking of follow up questions. Learning what works for them and how do they feel comfortable." [I1]

Students being in a safe environment to learn to Grace is about the physical learning environment and the relationships that teachers build with students. For Grace, everyday exercises like talking to her students and checking in also take moments to reflect by putting herself in her students' shoes. By Grace doing what some might consider small gestures are what she feels vital for students to be comfortable working to overcome any obstacles, they may have to learn and allow their teachers to guide them on that journey.

Creating Equity through Non-Monolingual Environments. For most of Grace's students, English is their second or third language. She works to create an equitable environment in her classroom by avoiding creating a monolingual environment. To do this, she opens her curriculum to all languages spoken by her students. One way she does this is by reading for them and to them in different languages. During the first focus group Grace said, "….that first week of school, I read for them in Spanish, I'll like read for them and other languages, and they listen to me struggle." [FG1]

Grace feels that by reading in various languages, she creates an equitable learning environment that shows that all languages have value in her classroom and not just English. She also

wants to make sure students feel comfortable to be vulnerable and make mistakes. Grace said, "…that like creates that, okay? If she's willing to, like, try and laugh at myself and stuff, then it kind of like paves the way" [FG1]

During the second focus group for one of her example artifacts, Grace brought pictures of her classroom. In these pictures, she had pictures of all her lab tables that had the word 'welcome' in the different languages of her students. To do this, Grace said:

> "So, I just like to put a post on social media, it's okay, if you speak a language other than English, send me a message and tell me how to say welcome. So it wasn't just like the kids I teach was also like some of my friends and so I have Spanish, French. So I have Vietnamese, Arabic. And then I have two African languages. Amharic and Yoruba. Um, and then a Mandarin." [FG2]

Even on her windows, she has the words "All are welcome here." Grace said, "I hope that for kids to see their own language makes them feel welcome, would be my hope for that, I guess." [FG2]

Even though Grace has made efforts to include languages of different cultures in her classroom environment, these languages are still not found in the curriculum students have to engage in. Yes, Grace has students read aloud in different languages, primarily Spanish, but unfortunately, there were not many examples of how she makes an equitable space for multiple languages within her curriculum. However, another artifact that Grace discussed was how she makes space for multilingual discussions by having students explain different topics to each other. For example, a student might not understand how she explains something in English, but she will have another student aid her in explaining the concept to the student in their primary lan-

guage. Students also use their primary languages to work together collaboratively on assignments to help each other better understand concepts to produce different products such as projects. Grace's classroom welcomes all languages of her students, but it is hard to welcome all languages within the curriculum.

Teachers Working as a Collective. Grace is a part of two different curriculum groups because she teaches both sheltered physics and chemistry. Curriculum groups are a group of teachers that all teach the same content discipline. In these groups, teachers work together to discuss strategies, craft tests and discuss other things like pacing calendars. Currently, Grace felt that her curriculum groups spent more time working on deconstructing tests than putting their minds together to discuss ways to improve the learning of all students. Grace said during the first focus group, "Like we need to, like be pouring out, like, our knowledge our brains we went to college for, its not to be like, Well, I think that "C," it's kind of a distractor." Grace then went on during the first focus group and discussed primary considerations for improving how time is allotted during the curriculum groups. One of her most significant suggestions was how curriculum groups should work together as a collective and not as isolated individuals. Working as a collective collaborative group according to Laal (2011) allows a group to come together to focus on common goals and communicate effectively, because the purpose of them working together is apparent and clear.

Further, she felt teachers should see all students as 'theirs' no matter their learning level. Grace felt that teachers working as a collective would allow for all the needs of students to be met for a particular content course because teachers would work together to use their different certifications, like gifted or ESOL, to create equity for all students in the curriculum. She learned about teachers working as a collective from the literature given for the first focus group and from

her past middle school experiences. She talked about seeing students as "all ours," meaning all students belonging not to one solo teacher but all teachers in a content area, would allow teachers to work collectively and create resources that can work for everyone. Thus, working as a collective and not just as individual teachers trying to meet their individual needs. During the first focus group Grace said:

> "Um, but we saw it as, it's not just the eighth graders that I teach it is they're all our children. So, the gifted kids are ours, the ESOL babies are ours, the resource babies are ours, the on-level babies are ours. So, let's put our heads together with all of our knowledge teaching abilities and make resources that work for everybody."[FG1]

Grace felt direction from leadership that helps the curriculum groups to run more efficiently is necessary to work as a collective. Curriculum groups must spend less time creating tests, breaking down answer choices, and using more time to build resources for students.

> "If we had the direction, or the leadership to make our PLCs run efficiently, these are the kind of thing I don't want to stare at the test and break down the questions that's not going to help our babies."[FG1]

To do this, Grace says there has to be some training or professional development, but there has to be a mindset switch so that training can be practical. Teachers must see students as belonging to them, and their learning is relevant to them no matter the level. Grace said:

> "I'm just saying that until we all see them as our kids and not your kids and your kids and your kids, it's not going to get better. So, like, to me, that's the biggest change, like, yes, we need training, but until it's a mindset switch, that they are all of our students, then I'm like, it's just gonna go one in one ear and out the other because you're gonna think it doesn't apply to you."[FG1]

Desires for more Opportunities to Learn. One of the final themes that arose throughout Grace's interviews and focus groups involves teachers wanting to learn how to create equity and how much information exists about equity. However, teachers also need dedicated time to learn about equity and the opportunity to learn from each other. Referring to one of the focus group readings, Grace said:

> "… it's talking about the teachers who went through training. And at the end, it says, however, as a result of an intensive professional development program to support the teaching of inquiry-based science teachers in these underserved schools begin to build productive social resources."[FG1]

Given the opportunity to have training or teacher education for educators that was not just offered once throughout the year but constantly, Grace felt teachers would feel more capable of creating more equity in their content. Grace also said: "I think the biggest or one of the bigger things was that there is a lot of research out there. That's been done that I wasn't aware of. And there's a lot of, I think, information that could be shared with teachers, this may be not being prioritized."[I2]

Grace thinks that there are probably many other teachers who are willing to instill more equity into the curriculum, but she said that teachers would probably be more willing if there were some models that were presented to teachers that can be taken and adapted for our classroom environment. "I think teachers would be more willing. You know, we'd like to borrow, we don't like to create. And so I think teachers would be more willing to implement if there was some stuff that was created."[12]

Looking forward to the future, Grace would like to take the information she learned from the reading given during the focus groups and information learned from the other participants to

create equity in her content. For example, another participant, Jordan discussed how he uses a song every day to discuss with students what was going on in science on that day. Grace expressed interest in using this approach to amend some of the curricular choices she made in the past to make them more equitable. She is also doing this as she chooses courses for her next degree program, which she views as another opportunity to learn about research-based practices for creating equitable classrooms. During her final interview Grace said:

> "Um, I think, um, I definitely want to go back over the summer and go back through those articles and read them some more and write out some, like some, some do's some actions from those. And then I'm also as I finally go back to school and pursue a master's, I want to make sure that if those classes are available to me that those are ones that I prioritized."[I2]

Grace's Connections to Equity

Grace's interviews and focus groups all show that she wanted her students to see that they could be successful, and she wanted to do her best in creating an environment where they could do so. Along with creating this environment, Grace also wanted to learn about even more ways to create equitable learning spaces for students and work better as a collective with other teachers in her curriculum group. Overall, these themes demonstrate how Grace wants to create equitable environments for her students by showing them, they are essential, and they matter, not just when learning, but they matter, period.

The artifacts and the descriptions of her classroom that Grace presented are a start in creating an equitable classroom learning environment, but it is also important to remember that it also needs to be reflected in the curriculum to have accurate equity. According to Crawford Garrett (2020), when being equitable in curriculum, it is essential to build a curriculum in which

standards are learned within students' lives. However, as Garrett also said, curriculum designers, do not always consider equity when creating standards (2020). Overall, some examples of how Grace made her curriculum equitable include how she has students discuss and help each other in their first language while they describe different concepts in class. However, it is possible for Grace to take a step further and make space for equitable curricular decisions. For Grace to learn more about how to make not just her space but her curriculum equitable, she would need professional development aid. Teacher education is crucial to Grace developing strategies that help her incorporate her students' lives in her curriculum, even though few models currently exist on how to do this (Trent et al., 2008). As stated in the literature, teacher education is an integral part of teachers knowing and understanding how to effectively and confidently created equitable learning spaces in opportunities not just in the classroom learning environment but also in the curriculum (Paris, 2012).

Grace's need and want to create equitable learning spaces through building relationships with students connect to how culture is vital to creating an equitable learning space in a science classroom. However, to do this, teachers have to be willing to learn from themselves and each other. This learning has to be a priority to educational stakeholders like administration that control how teachers work together as a collective. Grace will continue her learning in the upcoming semester in her master's program to move forward with her education on equity.

Ashley

Ashley was a middle school teacher before she transitioned to high school. She completed her teacher education courses at a public state university in the southeast US and is currently pursuing her doctorate in curriculum and instruction and at private university in the southeast U.S. During her teaching education programs, she did not remember equity being explicitly taught, but one of her professors did have students complete an implicit bias quiz tailored to race. There was a sparked discussion about racism and institutionalized racism through this quiz, but as she said, things fell off after that. Ashley also stated that she had never experienced anything significant when learning about creating equitable spaces in science. When asked what equity meant to her, she referred to Maslow's hierarchy of needs being met before learning. The examples she gave of these needs were asking students how they are doing and checking in with them constantly. From her interviews and focus groups responses, three themes emerged: teachers doing the work of equity, addressing the needs of students, and the importance of incorporating cultural experiences into the classroom learning environment.

Teachers Doing the Work of Equity. One of the most important themes throughout the interviews and focus groups for Ashley is how equitable classroom learning environments cannot happen unless there are teachers there to facilitate them. In order to facilitate these spaces, Ashley says

> "….like to host an equitable classroom, you have to know yourself and, also who you are and what you're about as a teacher as an educator first, because then once you're kind of like, confront your biases, or your opinions are, whatever it is, and move past them, then you can start addressing the needs of your diverse learning crowd" [FG1]

Teachers influence equitable classroom environments a lot because they are primarily responsible for assignments and how discussions can flow within a classroom (Garrett, 2020). Ashley pointed out how it is also up to the teacher not to skip out on hard conversations because of immediate discomfort. Ashley described that as a privilege to decide not to confront something just because it makes you uncomfortable. Ashley also said there has to be equity not only in the actions of teachers but also in their thoughts. During the first focus group, Ashley reflected on how teachers create equity in their classrooms.

> "….type of assignments and being mindful of myself personally because everything rolls downhill. I have to be equitable in my thoughts and my actions. Also, do not skip out on hard conversations. Being able to skip out on hard conversations is a privilege." [FG1]

In the second focus group, Ashley described one of her artifacts which was focused on academics and how she creates equity in her assignment choice by giving students a choice board to illustrate their understanding of the content on a summative assessment. She used a choice board that gave students numerous mediums to illustrate their knowledge. Ashley said that she felt this activity represented equity because,

> "…. you're allowing kids to play to their strengths, because every kid is just a little bit different. And so like, forcing an art activity on kids who are, you know, the numbers kids, or vice versa, like, you can do that sometimes to help them grow and push them but giving them an opportunity to show what they know in a way that they feel comfortable in." [FG2]

Ashley explained that her students expressed surprise that they got the opportunity to choose which assignment they should do. Usually, students are not given much choice in how they ex-

press their knowledge. Students usually have to take a multiple-choice test. Ashley had conversations like this with her students when they learned they had a choice, "And they're like, I really can pick anyone. I'm like, Yeah, go ahead for it, you know, like, pick whatever you want.[FG2]" To create assignments like choice boards and other equitable activities that play to the strength of students', teachers need time to work collaboratively. According to Laal (2011) working collaboratively is the philosophy that we are all responsible for our actions including each other's learning and we are going to respect the contributions of our peers. Teachers working more collaboratively allows all participants to leave with a diverse understanding of certain topics. Having a diverse understanding will then benefit students because teachers will be able to provide multiple ways of access to the learning curriculum and perspectives thus providing an equitable classroom learning environment.

Ashley discussed how most teachers get most of their planning time during the summer before the school year to start creating assignments for the next school year during the first focus group. Ashley does not think this is enough time to do adequate planning to create equity within the curriculum for diverse learners. She also feels that to create equity into the curriculum effectively, there has to be collaborative planning that does not only happen once throughout the year but often. Ashley discussed some things that would help teachers have time to work together:

> "I think what should happen is like, a pre planning and or summer planning, that's, you know, paid for, where we get two or three days before the school year even starts. And then once a month, check it in progress, okay, this is what we're implementing this month, this is we're gonna see how this works. If it continues to work, let's continue to implement it. If it doesn't, let's change it up and think of some another way we can address that area. So I think once a month could be fine, as long as we would have

> enough time before the school year starts to actually sit down and like just because I feel like there needs to be at least one meeting where it's just ideas, just throw ideas, right? They would just be really, really nice." [FG1]

She also highlighted how the influence of standardized testing could restrict the curricular decisions of teachers to create an equitable space for students, especially for diverse ELL learners. She calls this influence the institutional piece in how teachers can create equitable learning opportunities.

> "…. teachers are killing it, putting in work, trying to be creative, trying to do new things, but being tied down to the institutional. Thus, it is like we have to fix the institutional first because I feel like the other two are happening for many teachers. You see many teachers interested in perfecting their craft or improving it to provide equitable spaces for diverse learners and things like that. But until we fix that institutional piece, that is where there will be true freedom to do the stuff." [FG1]

Overall, during both interviews and focus groups, Ashley made a point to say how making more equitable curricular decisions would be accessible for teachers if there were more dedicated training and more opportunities for teachers to work collaboratively. Teachers have a significant influence on creating equitable opportunities for all students, but if they are not given access to proper training and priority is not given to working collaboratively. Johnsons (1994) pointed out that for really work towards a common purpose like providing equitable learning spaces for students there must be more of a frequency in collaborative time to improve the groups effectiveness. It is hard to create equitable learning opportunities in the curriculum. Along with professional development, teachers must be willing and open to recognizing and

working through their own biases to facilitate equitable learning environments for students better.

Addressing the Needs of Students. One of the first statements Ashley made during her initial interview was about the needs of students. "To help people be successful, they need to be provided with an equitable opportunity….". In order to create an equitable space, teachers have to be willing to address the needs of the whole child, not just the parts that can score high on standardized tests. "Like if we're supposed to teach, you know, they talk about teaching the whole child thing, though, is like, how can you teach the whole child without having an inclusive space?" [I1]

Ashley describes inclusive spaces as multicultural classrooms that welcome different people and cultures and brings honor to diverse cultures through the curriculum. Ashley suggests that she addresses the needs of her students by doing simple things like checking in and being aware of the choices she makes as a teacher. In Ashley's initial interview, she said:

> "It's really Maslow's hierarchy of needs that need to be met before students learn. Asking kids how they are doing today. Checking in. These are kids and they are adolescents. They need particular things to be successful from the start. Basic needs first. Making sure as the teacher to be aware of the choices I make with student grouping and its very sobering to find out how much access students don't have to technology" [I1]

During this particular school year, a global pandemic changed the way teachers had to teach overall, so making choices based on technology had to be equitable and shed light on the resources that students do and do not have.

One way that Ashley checked in with her students was discussed during the second focus group. During the lunch period, she opened her room to her student's past and current to give

them a safe space to hang out during lunch. During this time, they engaged in conversations with each other and Ashley that they usually do not have an opportunity to do during the class period or even have a safe place just to be themselves and relax. She finds it very important to not just look at students as just students, but as humans. Ashley used this lunch space as a classroom environment equity artifact. Even though Ashley opening up her classroom didn't happen during class time, the interactions that she had with students still helped her to find ways to connect science content to the lived experiences of her students.

> "…providing a space for them to where like, some of the kids that come in are the kids who are running up and down the hallways all day out of class, not doing what they're supposed to do. And I'm like, this is a place for that where they can come in, sit down, talk crap with each other, get on their phones, whatever, but there, but it is supervised, I'm there, I'm listening, I'm watching. But also just kind of giving them free space. So like, have your conversation that normally in class, I'd be like, hey, hey, hey, you know, like, whatever, giving them an opportunity to have and build on their interpersonal relationship skills." [FG2]

Essentially, addressing the needs of students for Ashley can be as simple as just checking in with them or creating a safe space for them to have lunch. No matter which way, the important thing is to allow students to engage in dialogue with the teacher and even each other to build those relationships. Building relationships with students contributes to the teacher's ability to create equitable learning spaces for students. According to Olitsky et al. (2010), when teachers incorporate their students' backgrounds and cultural knowledge into the classroom curriculum, they make them valued contributors and not just passive participants. Ashley tried to create

spaces for her students so they could feel safe being themselves. Their teacher gained the opportunity to learn about them to then use the knowledge she learned to help her students develop meaningful connections to the curriculum.

Importance of Incorporating Cultural Experiences into the Classroom Learning Environment. Ashley emphasized the importance of building relationships for teaching diverse learners. This allows the teacher to know important aspects of their cultural backgrounds and incorporate those details into the curricular decision-making that happens throughout the school year. When teachers take time to learn information about their students, it can significantly impact how they learn in the classroom.

> "… it is like we know something about them or that there is some sort of connection there. And I think that that plays a really big role, because I think kids do have to be comfortable in a classroom to effectively learn." [FG1]

However, to incorporate the culture of students into curricular decisions, teachers have to be able to recognize and value the culture of their students, because according to Ashley, it gives students the sense of being seen. Students being seen and valued gives them a sense of belonging to the classroom learning environment and makes them more willing to participate in the learning process. (Olitsky et al. (2010)

> "…And so by, like, recognizing culture, in all of its many aspects, I think is such an important step, because, you know, they have to feel connected. And also, it's kind of like a, I wish there was like a social emotional hierarchy of needs. And part of that is like, needing to feel seen, and heard and comfortable, to share, you know, things in class answers to questions to ask questions, things like that." [FG1]

In most of Ashley's responses to interview questions and during focus group she did not clearly define her understanding of culture. However, it is clear to the researcher that Ashley's understanding of culture is based on the backgrounds and previous experiences of her students. Building relationships to learn about the various cultural experiences of celebrations like quinces or religious celebrations can be difficult when working within the standardized education. As mentioned previously by Ashley, standardized tests and standards are a part of the institution of education. Ashley discussed how keeping up with standards and meeting the requirements of standardized testing affect how much time there can be spent to building relationships through talking to students individually sometimes and not as a full group. Ashley stated, "there's, there's so many rules that we have to follow. I feel like sometimes it kind of puts a damper on the relationship building", "So it's like, not having the time, our content is so packed that like, Where's the time for conversations?"[FG1].

Ashley talked about how she wants to make an extra effort to show more culturally responsive scientists to her students for the first focus group. She wanted to show her students scientists who do not come from the traditional societal conceptions, also scientists who had to overcome obstacles or barriers that tried to keep them from being successful.

> "And so also the like, portrayal of scientists in every movie and TV show that they watch are these super smart, nerdy, like, have to be good at school have to be obsessed with reading books and you know, XYZ have chemistry sets in their house. But in reality, there are so many scientists who have learning deficits or other sort of like barriers to their success, but we don't talk about them. And so because they don't get mentioned, they don't know that there are some scientists that are like them that there are scientists who couldn't read or who didn't do this."[FG2]

Ashley believed that showing scientists from similar backgrounds showed students that they "don't have to look a certain way or be a certain way in the classroom at school to be able to do science…."[FG2] The goals of Ashley as an educator in creating equitable spaces for her students were made apparent through her interview and focus group responses. She wants to make sure students feel heard, safe, and that their needs are not just met as a student, but as human beings. Ashley created equity in her classroom learning environment by creating a safe, welcoming space for students and in the curriculum by giving them ways to assess themselves with choice boards and not traditional paper-pencil tests (Glatthorn,1999). Ashley's responses connect to the themes of the needs of teachers and culture in science found in the literature review of infusing culture in science by creating equitable classroom learning environments (Barton & Tan, 2009; González, Moll, & Amanti, 2005). Ashley finds that creating equity for students is an integral part of the learning process. Throughout the study, Ashley focused on the needs of students and how they can only be met if teachers and other stakeholders make themselves available through thoughts and curriculum to do them (Trent et al., 2008).

Evelyn

Evelyn has been at the study school for about five years and has taught sheltered biology and forensics. She received her teacher education through a program called Teach for America in Brooklyn, New York. During her time with TFA, she said that equity was discussed all the time, and the program wanted to make sure that the teachers were always aware of their own biases and how they could affect their teaching practices. Evelyn noted that the CEO of TFA was up-front about the white savior complex that existed among some teachers and teacher programs and

wanted to make sure to address it with the TFA participants. The white savior complex is indoctrinated to many pre-service teachers and makes them view themselves as heroic liberal warriors who save students of color from failing (Matias, 2016; Vera & Gordan, 2003).

Evelyn described equity as making sure that all her student's experiences are valued in her classroom space. She also wants to ensure that cultural responsiveness is extended to her teaching content, but even more, while students are doing labs. Evelyn was one of the only participants that spent a reasonable amount of time teaching within a school system in another state. Throughout her interviews and focus groups, four themes emerged: Changing the view of science and scientists, Teachers' role in creating equitable learning spaces, How equity functions in school, and Getting students to see the future.

Changing the View of Science and Scientists. The idea of changing the narrative that currently exists in schools surrounding what science could be and who are scientists was evident throughout the interviews and focus group responses from Evelyn. She consistently talked about how important it was for students to see science function differently and how the people doing science were not always white men. Evelyn talked about how she placed info cards about the different scientists around her classroom to perpetuate this narrative of diversity in science. During the focus group, she said:

> "So, I made like, cards, basically, that like are still in my room, that are like scientists that actually looked like my kids. So like female scientists, African American scientists, Hispanic scientists and Asian scientists and whatever, just because I wanted them to see that. That's what scientists look like. They're not just white men, even though biology, a lot of who we talk about is just white men." [FG2]

She was one of the only teachers who talked about how science can seem like such a challenging career pursuit to students because of how it has consistently looked in science textbooks and pop culture. To help with this view of science and to make it more accessible for students, Evelyn wanted to take a deeper look into social media scientists and share them with her students. Her most significant intention was to broaden her students' horizons for what scientists looked like so they could "see themselves in science" and even show them how they do science all the time. Evelyn emphasized how science is just not done in a lab, but other branches of science exist. Evelyn mainly teaches just forensics and sheltered biology, but she wanted her students to get excited about the other types of science that exist in the world. During the 2nd focus group, she said:

> "The other reason why I like it is it's not just biology. So I've got like anthropologists on there, and I've got like, astrophysicists on there. And just like, I also picked some that I just thought were cool jobs. So that they'd be like, what's that? Like? I have Neil deGrasse Tyson on there, because he's famous and they know who he is." [FG2]

Evelyn also looked to social media to show her students the other types of science and cultural backgrounds of people doing science. Evelyn wanted to show students that there are many representations of science and scientist. She found it necessary to show that you can be a social science communicator and explain the different scientific phenomena. For this reason, she wants to incorporate more social media scientists that show students the multiculturalism of science. Also, in the 2nd focus group, she said:

> "I think I'm going to start incorporating some of the like, social media scientists, like Raven, the science Maven, and like some of those that are like getting really big on like Twitter and stuff that some of these kids might be seeing on like, Tik Tok. Being like,

this is a scientist too, though, like science communication is a huge way to be a part of the science world. You don't just have to be in a lab. FG2]

One way that Evelyn thought about getting the narrative about science to begin changing for her students was beginning the school year just thinking and talking about science. One purpose of wanting her students to see science from a different perspective was to see science as more of an attainable career goal and not just some abstract, unreachable concept. To get her students thinking about science in different ways, Evelyn suggested asking her students' different types of questions to help them explore their previous beliefs of what science and scientists could be. During her final interview, Evelyn said:

"What I would love is if That first couple of days when we just have freshmen in the building as to maybe that's the focus instead of even looking at content at all. It's just like, what do you think a scientist? What does it look like? Who gets to be a scientist and that kind of thing? And then have to start building that right away." [I2]

Evelyn teaches forensic science, which is usually a senior class or what is considered a fourth-year science. Sometimes depending on the room in their schedule, sophomores and juniors could be placed in this class. Unlike biology, in forensics, there is more space within the curriculum for students to discuss science as career goals than they would in biology, mainly because there are fewer standardized tests than required in biology. Evelyn wanted students to have the opportunity to see science as a future career goal. This is done in forensics by having students do career posters and having guest speakers come in a talk to students about their careers, and allow them to ask questions. In the second focus group, Evelyn said:

"But science is also a career option. And there are things you can do kind of like when we do the career posters and forensics. And we're like, you could do this like dope

> poster on a mortician, and they're like, man, morticians make a lot of money. This is really cool." [FG2]

Evelyn wanted to change the narrative of what science means for her students. Evelyn wanted her students to not just see science as what a challenging class can sometimes be to understand or a class they just needed to pass on to the next. Overall, Evelyn wanted to help her students see how science can function in their everyday lives and even be a career choice. She did this by creating an equitable space in her classroom that showed her students the possible scientific careers and showed her students the different ways science can be done. This is a reasonable effort on Evelyn's part, but options remained where she could incorporate those different views of science and career opportunities into her curriculum, rather than simply extracurricular materials present in her classroom. To create a space for students to explore science at a greater depth than usual, Evelyn also had to address her role in creating equitable learning spaces for her students.

Teachers' Role in Creating Equitable Learning Spaces. In Evelyn's first interview, she spoke of how students need a space where they are heard and influence their environment and see the value in what they were learning. She wanted every student to feel like they belong in her classroom. She reflected on what it felt like to not belong in a classroom and how it affected her trajectory as a math student. She said:

> "For example, in 6th grade, my math teacher told me I might as well stop trying because I am a girl, and it's not that important. Till this day I am bad at math. I can't pinpoint when exactly this happened, but I'm sure it had something to do with that teacher. I don't want my kids to feel like I don't look like a scientist, so I don't belong here. [I1]

One of the critical ways Evelyn worked towards helping her students feel like they belong in her classroom was by addressing assumptions they may have about her and her life. For example, during a genetics lesson in biology, students assumed that their teacher's family was "perfect" or had a more traditional family unit of mom, dad, and siblings. .To address those assumptions, Evelyn found it necessary to share her family dynamics with her students. In her second interview, she discussed what happened during the genetics lesson.

> "Oh, you know, for genetics, I will put up a picture of my family. I've got half-brothers and stuff. I got all kinds of family because we have multiple divorces. And I'll be like, Who's my full blood sibling? And they're like, what I'm like, yeah, some of these are halves. I got steps in here. Like, who's the only one related to me? And they're like, you got a family like that? I'm like, Yeah, but I do. [FG1]

Evelyn showing her students a glimpse into her life by showing them a picture of her family and discussing her family dynamics was Evelyn's attempt to break down the barrier between her and her students. Evelyn also described taking steps to break down barriers by addressing her English language learners, who are primarily Hispanic, assumptions they have about her and the assumptions she may have about them.

Concerning her assumptions about her students, Evelyn learned that she could not assume all her students spoke Spanish. Evelyn spoke about this assumption of her students in her final interview.

> " Some students absolutely cannot speak Spanish, or they can speak it, but they can't read it. So like if I wanted to help them and be like, oh, here's this article in Spanish. They're like, I'll read Spanish. And I'm like, yep, that won't help you will it or like, Oh, this means this in Spanish. And they're like, I don't know that word. Like, I can't make those

> assumptions either. Because a lot of my kids were born in the US and their parents didn't teach them Spanish necessarily, because they're like, you don't need to learn that you're in the US now. That's why I moved here." [I2]

Evelyn feels that teachers must be willing to build relationships with students so that both parties feel comfortable to address assumptions they may have about each other and move past them. As Evelyn said, building relationships with students allows, as Evelyn said to help motivate them with something else besides just their grades.

By building relationships with students, Evelyn helps students navigate through the ins and outs of schooling. This navigation helped students to be more prepared for the future. During her final interview, she described a situation with some of her ELL students whom she thought were copying each other's work. After further investigation and talking to them, she learned that one student was teaching the other student the material. Evelyn took this opportunity to explain to them that if they plan to further their education, for example, this type of collaboration could get them in trouble in college. After learning what students were, Evelyn stated that she liked what they were doing but going forward, it would be necessary when creating equitable spaces for her to compliment them on their ability to work collaboratively and offer critiques on ways they could work better collaboratively. As a teacher, Evelyn does feel that it is her job to help her students learn how to 'do school' or 'play the game of school' to set them up for success in their future no matter what they want to pursue. Setting her students up for success in the real world and creating opportunities for them to learn is another way of how Evelyn creates an equitable space in her classroom. During her final interview, she stated:

> "I do think it's my job to teach a kid how to be collaborative, and how to like, you know, work through the school space. And sometimes that's playing the game. And sometimes

> that's, you know, figuring out what battles are worth fighting. And sometimes that's getting to know a teacher to know what you can get away with and what you can't like, those are real world things" [FG1]

Creating a space of comfort through building relationships with students is essential to Evelyn to do what she feels is her role as a teacher to make sure her students are prepared for whatever future they want to pursue. Creating this space takes work from both teacher and student, but Evelyn's responses demonstrate the importance of the teacher being the first one even to provide that opening. Evelyn has done work and wanted to create an equitable classroom learning environment for her students. In the final theme of Evelyn's interview and focus group responses, the function of equity in schools was discussed.

How Equity Functions in School. Like other participants, Evelyn felt equity functions in how classroom learning environments are built through curriculum and physically, but teachers who facilitate these spaces still have to rush through the curriculum because of standards and standardized testing. In the first focus group, Evelyn talked about how hard it is sometimes to create equitable classroom environments for students because the standards they have to learn to seem overly full of material. In previous years there was room for kids to have opportunities to engage in learning about the nature of science, but those opportunities somewhat disappeared. In her final interview, she spoke about how her biology classes are structured at the beginning of the year:

> "It was nature of science the first week, wasn't it, and then immediately, they push, they put more stuff into our standards, and it disappeared. You don't have to start biochem like day one, which we push to day two."[I2]

However, in her forensics classes, because they are not burdened by standardized testing and thick standards, she feels she has more autonomy to do what she feels is more beneficial. Evelyn talks about how changing the curriculum just slightly allowed her and the other fellow forensic science teachers to build more relationships with their students and adapt the curriculum to what was relevant to different topics in forensics. One of the forensics teachers had mentioned watching a documentary called *Atlanta Missing and Murdered* and wanted to find a way to help students make connections between forensics topics and the history of a familiar city. Through this documentary teachers took time to have meaningful discussions that centered around current events and social justice. Engaging students in these discussions was not in the curriculum, but by the forensics teachers working collaboratively we were able to find a space within the curriculum that made sense with the content. During the first focus group, she said:

> "But then this year, in forensics, we decided to scrap the first unit because it's boring. And students don't really care about history of forensics, because we can teach that while we teach the stuff. And we did our own thing. Yeah, that like built relationships with kids. It was relevant to what was going on in the world."[FG1]

Evelyn also feels like standardized tests control how kids are taught in the classroom and hinder them from genuinely exploring critical thinking and breaking down questions because there is not any time. Standardized testing caused Evelyn to spend less time on certain concepts simply because testing blueprints said there would not be many questions on the subject on the test. When Evelyn compared to how other countries rank with test scores against the United States, she felt that because teachers had more training and more autonomy in their classroom, their kids performed better. In the first focus group, she said:

> "They don't have that critical thinking to be like ‘Alright, what is it like?’ What is it similar to what can I do about it, but we have so much stuff jammed in that we can't do that with them anymore of like, we used to be able to sit down and be like Alright, let's break down this question. Let's circle our keywords. What vocab? Do I know what are what whatever and then It's like, I have a day to teach you succession. Maybe you'll see a question about it, maybe you won't. Who knows? This is something that could be really interesting and cool and lead directly into human impact and carbon cycle and all this really great real-world stuff. It's just, it's frustrating."[FG1]

When schools’ subject students to atmospheres governed by testing and not by learning, Evelyn felt that we have to think about what we are teaching our students. Evelyn wondered if we teach students to develop a love for learning, or are we teaching them how to take tests. Evelyn stated in the first focus group this statement:

> "So we have to reevaluate what we are holding, as important. Do we want them to be citizens of the world and to love learning and to want to be like, we're talking about being scientists and being observant and asking questions, or do we want them to be good at taking tests?" [FG1]

From focus groups, artifacts, and interviews, Evelyn's responses indicate that creating an equitable space in her classroom is something that she holds important. She wants to help her students navigate through the ins and outs of schooling to help them be successful beyond school. Evelyn's classroom environment artifacts start creating an equitable learning space for students by showing them the possibilities of scientific careers. Unfortunately, this was the only artifact Evelyn shared in nature to how she creates and equitable classroom environment for her students. However, Evelyn also feels that a lot of her work to create an equitable space for her

students is hindered by conforming to environments governed by standardized tests. Despite having to conform to standardized tests, Evelyn still creates equitable learning spaces by building relationships with her students and recognizing how her assumptions could impact her curricular decisions for her students.

Jordan

Jordan was the only male participant involved in the study and taught longer than any other participant at about 23 years. During his first interview, he stated that he was not planning to be a teacher, but he was researching fish and wildlife services. Jordan has a Master of Science in Wildlife and Conservation Biology. His journey to becoming a teacher began because he was in a romantic relationship with a teacher. Because they moved to a new city, he reluctantly took a middle school job teaching 7th-grade life science. This was his formal introduction to public education. He eventually taught high school biology because a principal had just had one of his teachers quit, and the principal suggested the job to Jordan. He started teaching at this high school and decide to go back to college and get his full teacher certification. During his initial teaching program, he did not recall explicitly learning about equity but did remember discussing strategies to teach students from different countries. Jordan presented a difference of perspective of the idiosyncrasies of teaching compared to other participants. During his teaching career, he has taught chemistry, physics, and biology. Throughout the interviews and focus groups, three themes emerged for Jordan concerning his thinking about equity: Journey to overcoming limited understanding of equity, the autonomy of teachers, and Creating equity for English language learners within the science curriculum.

Journey to Overcoming Limited Understanding of Equity. Jordan's first definition of equity was something he struggled with but was eventually able to provide. During the introduction interview, he defined equity as:

> "I would think a level playing field. People who are fortunate and have had all types of opportunities and experiences because of their background. Everything is the same. Same across the board. Every student gets the same opportunity to learn and leveling the playing field making it I don't want to say equal, but I guess you could say equal." [I1]

Throughout the interviews and focus groups, Jordan offered much insight into what professional development and other learning opportunities prioritized teachers at this particular school. The professional development happened right when the school demographics started to change from mostly white students to mostly Hispanic students. The administration felt it important to start educating their teachers on strategies for English language learners through a program called SIOP. Jordan worked at the school for about 20 years, teaching with 4 or 5 different administrations. During the first focus group, when other participants were discussing how they have not received any professional development or significant learning opportunities around how to build equitable spaces for diverse learners, Jordan offered

> "I was just gonna say, not necessarily true that we haven't gotten training on this stuff. It's just that that governs with administration's and which administration puts emphasis on training of that, you know, there have been previous administrators who did put the emphasis saw the need to get regular ed teachers into some sort of ESL training or ESL training or even sped training, you know, that again, that really just depends on where they're putting the dollars in for, for staff development, and stuff like that." [FG1]

For Jordan, it was evident that the most significant element of creating equitable spaces in the classroom for his thinking was meeting the needs of English language learners. He discussed that ELL strategy training was the only significant effort to learn about equity in professional development. So, when talking about equitable learning, Jordan consistently referred to the experiences of ELL students. Considering his classroom, he did not think of what he did as creating an equitable learning environment. However, after the first focus group discussions about equity, he could reflect and see where he was attempting an equitable learning space. One event where he attempted to create equity was his song of the day. He knew how his kids liked music, and he loved music as well, so he used this connection to build relationships with his students. Initially Jordan did not think of his song of the day as equity, but the researcher and other participants assured him that it was. During the second focus group Jordan presented his classroom environment equitable artifact, he said:

> "I like music, I'm passionate about music. And so it's one of the ways that I can, you know, kind of bring everybody in on the same. Now sometimes they're gonna play stuff that that they don't necessarily like, but I always try to tie it to something that's going on. Usually it has something to do with science or something like that. But it's you know, it's a group of band a musical piece that that they may never have heard of." [FG2]

With his song of the day, he has themed months like Funky February, where he goes to the roots of hip hop and discusses how hip hop started. He explained further during the second focus group how he uses the day's song to make connections to science.

> "…it was just the anniversary, what was it the 35th anniversary of Chernobyl, right. Moreover, and I and this was a, we were just an April. Thus, it was Anything Goes April. And I heard that it was the 35th anniversary of Chernobyl. And while the kids have

> probably never heard of Chernobyl or anything like that, it's a nuclear, you know, accident. So it ties into physics. And then I knew that there's a song by Paul Simon called *Run* but can't walk. And it's from an album called the *Rhythm of the Saints*, where he was focusing a lot on South American rhythms and stuff. And so, the song itself starts off talking about Chernobyl and you wouldn't know based on just listening to the song because it's all very percussive with marimba and stuff like that and there, but the lyrics are all about, you know, guys digging in the dirt and cleaning the soil. Yeah. So that's, that's one of the things I do [FG2]

Even with Jordan's song of the day, he still finds it challenging to build relationships with his students that help create an equitable learning space in his classroom. The song of the day helps him spark those discussions with his students, but overall, he does not feel like he has the qualities that would help him dive a little bit deeper into the lives of his students. Jordan uses the song of the day as an opener to learning, and by this song of the day he is helping students make connections. Jordan even takes it a step further and sometimes allowed students to pick a song to make a scientific connection. He also came to this conclusion after noticing some of the characteristics of the other female participants. He said during the second focus group:

> "I don't have a whole lot of you know, I'm not a big touchy-feely kind of guy. You might, it might not, I don't know, seeing that, that I'm the only guy here, guy. So I'm not you know, I don't have a lot of them, you know, the, the overtly welcoming, and, you know, stuff on the walls and things like that." [FG2]

He felt some of his students might not quite get him and come into his classroom closed off anyway because he was a male teacher. Also, he noticed that because many of his students are minorities, that might also not deal well with him being a white man. During his final interview his said:

> "…you know, over the years, I have just gotten a sense of, you know, the fact that you're a guy, that's a problem right off the bat, doesn't matter what you look like, or where you come from, you're a dude, and I don't like dudes period. And that, and then, you know, maybe put it as a white dude, that makes it even worse, you know what I'm saying? And a white dude coming from a, you know, a position of some sort of authority. Yeah, that makes it even worse. [I2]

Further in his second interview, Jordan discussed how these feelings of students not liking his approach to his classroom management might be because of how other teachers have treated students previously. He said:

> "Well, that's, that's one of the things. I mean, that's one of my where I come from is like, you know, where I said, hey, it's time for you to pick up, you're by yourself by your seat of your pants and do this. My point of view is, you know, they've been, you know, babies in handheld all the way through." [FG1]

Jordan's thoughts on why students do not understand his approach to classroom learning environments also relate to their home environments. Many of his students have been brought up in matriarchal families. In these matriarchal family units, he said, "…in a matriarchal, you know, family unit. And so, it's all about loving and holding, and, you know, don't worry about it, we're going to, we're going to do, we're going to do it together, that kind of thing." [FG1] Jordan says that he is not about that because having behavior like that with his student makes him seem like a

"pushover" to his students. From the interviews and focus group, it can be gathered that Jordan takes an approach of you get what you give when building relationships with his students. During his final interview, he said:

> "So, if a kid comes walking into my class with an attitude already, right? He probably not going to like the response, I give them to that attitude, because I'm like, Dude, that doesn't fly here. Right? You know. And so, that might be perhaps the wrong way that we start off, but, you know, it's not like, I just like, let it fly." [I2]

Overall, Jordan makes an effort to create an equitable learning environment in his classroom by building a relationship with his students through music. Jordan making most of the music choices still leaves him in control of how students can make those connections and build relationships with Jordan. From Jordan's interviews, he has made it clear that the only authentic learning he has received on any type of equitable learning space has been through professional developments about strategies for English language learners. However, Jordan has discussed his barriers to creating an equitable learning environment for his students. For example, his barriers are his thinking about how students should be able to navigate school. He does not feel like students should receive any more support than necessary. Despite those barriers, though, he has still managed to find a way to connect with students to build relationships, even though it appears to be on his terms. The researcher discussed how Jordan created equity for English language learners within the science curriculum in the next section.

Creating Equity For English Language learners within the Science Curriculum. In Jordan's first interview, he discussed the most effective training about equity and ELLS. He received strategies and tools to teach English language learners to communicate effectively and teach content to these students. He spoke about how, for a while, there were no ELL physics

classes, and this school only developed one within the past five years. Before physics ELL classes were formed ELL students were just put into general education and not receiving the supports they would have if they were in a directed served ELL classroom. As a curriculum group, the physics teachers also tried to create more accessible assessments for English language learners. These tests had more pictures and more basic vocabulary terms for more complex testing words. For example, increase can be a difficult word for ELL students to understand, so by the word increase, there would be in parentheses the words ‘go up’ so students would have a clear understanding. Jordan provided an example of how his curriculum group added language supports to their tests and used it as his academic equity artifact. After doing this for one test, Jordan said the physics teachers saw how difficult creating equitable assessments were, especially when accommodating the languages for all students. During the first focus group, Jordan said:

> "…or at least what we tried to do it on one assessment, and it was great. There were pictures and everything like that. And, and but then when we brought it to the physics curriculum group as a whole, everybody says, well, but I've got so he's from Taiwan, and he doesn't speak Spanish. And the basically that was the majority of the questions were geared towards Hispanic Latin kids, because that was the majority of the kids that we had for ESL, but then there was the question about equity. Well, if you're if you're putting, you know, Spanish definition or Spanish words, next to English words, on the difficult ones, how is that equitable for the kid from Taiwan or for I had a kid from Nepal" [FG1]

Jordan had not had any experience doing this sort of thing before this experience with creating assessments. He noted how doing this task opened his eyes to how hard it is to do this equitably for students of all languages and cultural backgrounds, especially when preparing students for standardized testing.

When speaking on standardized testing, the next factor that plays a significant role in creating equity for English language learners is the schedule teachers have to adhere to when teaching, called the pacing calendar. Something Jordan noticed from the ELL physics teacher was how they would have issues keeping up with the pacing of the other teachers in the curriculum group. During his final interview, he discussed how ELL students do not have the time they need within the pacing calendar drafted for all students, no matter their learning barriers. He said:

> "… when they started to have an ESL class in physics, and Alice was teaching it, we knew right away that there was no way that she was going to be able to, keep up with our, our pacing calendar that she was going to be weeks, if not months behind us in terms of where we were on the calendar and where she was with our students." [I2]

Jordan had difficulty understanding why ELL students were not given a different pacing calendar than the other students. Giving ELL students a different pacing calendar to learn the physics standards would have been creating an equitable space by giving the students more overall time. He said in his second interview:

> "I mean, if you're going to tell me that you're going to I'm going to be teaching a class that are kids with language barriers, but you're still going to require them to take a test that even proficient language speakers would perhaps even struggle with some of the language or, or the amount of reading or whatever at the end that makes absolutely no sense."[I2]

Even though Jordan knew that changes need to be made to the curriculum, specifically for physics, to become more equitable for English language learner students to learn and understand the content, he also felt such changes would not matter because of standardized testing.

When discussing how to teach concepts like velocity to English language learners and knowing those concepts are challenging for students with no language barriers, Jordan knew that more time would be needed with language learners. In the final interview, he said this about adapting curriculum and assessments to the needs of English language learners:

> "…we were like, our tests, what are we going to do with our tests for kids that are ESL kids, and there was a, there was a, you know, a thought that maybe we should create more equitable tests, or at least more, you know, tests that were better easily are more easily understood by kids that were language learn, or suffered, you know, or dealt with secondary language. But it always came back around to they're not going to get that kind of commendation and modification on the standardized test that the county is made." [I2]

Although accommodating his teaching styles to address the influence of standardized tests, Jordan still finds issues with the tests he has to give his students from the county. His issue is that the tests are not just testing students on science concepts but their ability to read and understand a long passage. During his final interview, he discussed how, over the years, and the assessments have changed from being conceptual to being more about the depth of knowledge:

> "I mean, our tests and even the district tests were very straightforward, factual, conceptual. And now of course, there's that the move to being you know depth of knowledge. And all that means is a, we're going to give them a much longer passage that really has nothing to do with the knowledge that they have to, you know, convey the question, fluff. We're really Bluff, right? We're really assessing whether or not they can read and understand a passage." [I2]

Throughout all of Jordan's interviews and focus groups, he knew how much the language of physics could be hard to understand for all learners. Understanding the language of physics, along with the majority of his students being some type of language learners, according to Jordan, makes teaching physics complicated because he has to be constantly aware of phrases he uses to explain concepts. He discussed how in his CP or college prep classes which would be the on-level physics classes, and he noticed how he would have to watch how he used specific colloquial phrases to explain concepts in physics.

> "…whereas a lot of times in CP, you get kids that it's not their first language. And for me and my personality, I say cliches and metaphor phrases, yeah, things, you know that they have no clue on, and they've never heard before. And if they have a language barrier or , a language learner, they might misinterpret in some way, shape or form." [FG1]

Generally, during this study, Jordan showed he knew some changes need to be made for English language learners and the barriers like language that exist to their learning. However, Jordan did refer to language barriers as a way students' could be suffering and not how students knowing another language could be an asset to their learning environment. It is important to point out how viewing language barriers as a deficit could impact how educators make curricular decisions for their students (Garcia & Gonzalez, 1995). Deficit thinking is not linear with creating equitable learning spaces for students. Jordan has also discussed how standardized tests affect how teachers are able create equity in their curriculum by giving students enough time to learn and work with content. Overall, when reflecting on the responses of Jordan to the interview and focus group questions it is evident that Jordan needs to be aware of how he aligns language barriers to the suffering of students. He also can focus on working to find ways to create learning opportunities that use the diverse language of students as an asset to their learning environment.

For Jordan to reach a different conclusion of language barriers to learning it would be beneficial if he is exposed to professional development that explicitly illustrates how a students' primary language can be bridged into their learning environment to foster second language development. In the next section, I discussed how Jordan explained how standardized testing affects the autonomy of teachers to make decisions that can affect their capabilities to create equitable learning environments for their students.

Autonomy of Teachers. At the beginning of the first focus group, Jordan talked about how he used to be freer to do what was needed for students. This current school year was different because the global pandemic or COVID caused standardized tests given from the county to be suspended or state standardized tests not to be weighed much within a student's grade. Jordan said:

> "We had a lot more freedom, to do what we needed to do to, even to mod, you know, modify our assessments, based on what we felt was necessary for our students in the classroom. We can't do that today. It's just, you know, quote, unquote, on unheard of, you know, to do that, and especially now, I mean, it's coming off of this year for COVID. But we're going to go back to the same, you know, you know, district assessments…" [FG1]

According to Jordan, this freedom happened before policies like No Child Left Behind were put in place. He said this was when the significant shift happened towards emphasis being put on standardized testing. Ever since this shift, Jordan felt like he was "hamstringed" by the curriculum and more rigid in teaching styles to accommodate standardized testing. In the first focus group, he said:

> "I often think that I'm hamstrung by the curriculum that's given to us, and the standards that are given to us in the language that is used in those standards that is given to us. So

> in that regard, no. We all I often find that and as time has progressed, we, especially me, having taught biology, chemistry and physics now, you know, we're teachers in general, who are losing more and more of their autonomy, to do things like that. [FG1]

Interviewing and hearing from Jordan during focus groups was very interesting and contributed a lot to what has happened in the past at this particular school. He offered insight that only he would have because he has been at the school the longest. Throughout his interviews and focus groups, Jordan showed that he could recognize equity. However, he had difficulty viewing the diverse languages some students possess as an asset to their learning and not a deficit. Having a deficit viewpoint makes it hard for educators to create equitable learning spaces because they do not see the value in using students' cultural knowledge as assets to their learning environment (Lee & Buxton, 2006). He also sees how much work is to be done on a teacher and administrative level if there will be a change that will create meaningful, equitable learning spaces, not just in the classroom. Overall, Jordan still has a journey to gain a better understanding of equity, and this type of understanding can only be accomplished through equity-focused professional development.

Stephanie

Stephanie was one of the quietest participants during the focus groups. She spoke more during her one-on-one interviews. Even though she did not speak a lot, she did agree with much of what was said during the focus groups. Stephanie received her bachelor's in criminology and then went on to complete her Master of Teaching. When asked if equity was discussed during her teaching programs, she said no; however, it was known among her peers , but not explicitly taught in a separate class focused on it. Stephanie is a special education teacher, and because special education was the concentration of her teacher education program, most of her classes were

geared towards special education. At the end of this school year, Stephanie left this school at the end of the school year to teach at another school that is not as diverse as her current school. Stephanie's definition of equity involved everyone being given the same opportunity and receiving support when needed. Through analyzing her responses from the interviews and focus groups, two themes were apparent: Influences of the pandemic on teaching practices and teachers and their part in the learning process.

Influences of the Pandemic on Teaching Practices. The global pandemic that occurred during the recent school year impacted how teachers could teach and how students were allowed to engage with one another. The degree of impact varied for teachers across the board because it depended on their comfort with interacting with students, particularly in a virtual space and also in person. For Stephanie, she still wanted to find ways for this pandemic to work for her. One of the ways the pandemic worked out for Stephanie was by giving her more autonomy in the classroom. During a usual school year, there are many district tests that kids have to score well on, but all district testing was suspended for this school year. The suspension of district tests allowed Stephanie to be more creative with her lesson plans. For example, Stephanie stated that she was able to try new things and bring in different ideas. Stephanie teaches special education students, so there is always a need to dive into the content even more. During Stephanie's final interview, she discussed how usually when students have to take district assessments throughout the year, there is a "time crunch." Hence, by not having district assessments this year, she had more time to take longer with a topic and have more time to break the information down. For this school year, teachers who teach the students made all tests and not by the district. The pandemic allowed her to have more time to spend with students to understand the content and not be hurried along because of district deadlines. In her final interview, Stephanie said:

> "Think that sometimes, like I'd like to get like, creative and do new things and like, bring in like different ideas. But this year, not as much since our tests were like, we didn't have as many, you know, district assessments and stuff. But it's so to the book, especially with a county that it's hard to take time, especially when I'm working with my resource, kiddos. And sometimes they take a little bit longer to understand a topic or I have to break it down a little bit more." [I2]

Having the opportunity to dive deeper into the content and create more learning opportunities for students to connect with content allows the teacher to be more equitable. Stephanie was allowed the space to become more equitable because she had more time to dive deeper into the content and give students time to understand what is being taught to them. The pandemic allowed her not only time to dive deeper in to content for better understanding for her students, but also provided avenues for her to build more meaningful relationships with her students.

The subsequent influence the pandemic had on Stacy's teaching practices involved students talking to each other. During the first focus group, Stephanie pointed out how she saw how kids could talk to each other, impacted their classroom comfort. Stephanie said:

> "…like, right now, it's hard, but like, I like to let the kids talk and be kids, and maybe have that time to just talk to one another and make sure they feel comfortable." [FG1]

As Stephanie reflected on her day-to-day routine in her classroom, she noticed where more time in her classroom involved her talking than her students. She also noticed how her students were spending too much time on their devices. Through these observations, she wanted to find more ways to have her students engage and learn from one another. The activities she chose were not always science-related but primarily were used to open up the communication space. She found the idea for these activities while scrolling through Facebook and coming across an

article. Stephanie used these questions as her classroom learning environment equity artifact. These conversations contributed to an equitable classroom environment, because it was a way for Stephanie to get her students to open up talk and help to build those important relationships with students.

> "I read this article attached to a Facebook post on how this teacher at the end of class, put all of their devices away and had students like put their phones to the side. And then they just talked, it didn't have to do anything about school subjects. They just talked. Because thinking about it, sometimes during class, you don't even really talk to your kids like as much as you normally would if it's asynchronous, or they don't have questions, anything like that. So we put our computers away for a second. And we just talked, and it had absolutely nothing to do with science. I asked them random questions. What would they do if they want a lottery? They could only eat one candy for the rest of their life. What would they do? And it just sparked some good conversation. And then they were actually excited to know what question I was gonna ask them next." [FG1]

Stephanie reflected how it was a good experience it was engaging her students in conversations. Her activities even encouraged students who did not usually talk to use their voices and get involved with the conversation. In the second focus group, Stephanie said:

> "So, it was it was a lot of fun to see what someone's answers were going to be compared to another person or actually hear the quiet person in our room that's never really talked before. Like, create. Yeah, you have a voice and get involved and ask other kids questions. So, it was just a good fun experience." [FG2]

Even though the global pandemic impacted how students and teachers approach schooling, Stephanie was able to use the pandemic to her advantage to spend more time teaching students by, as she said, diving deeper into the content. Even though Stephanie did not give any concrete examples of how she dove deeper into content, she did say that she tried to break the content down more for her students to help them better understand the curriculum. She did not let the pandemic circumstances like digital learning limit how she and her students interacted with each other. Overall, the pandemic gave Stephanie more time for things she felt mattered like student conversations and curriculum involvement. They did not have to keep moving to adhere to testing dates. During the interviews and focus groups, it would have been more impactful to learn about the different ways that Stephanie dove deeper into the curriculum to create more equity because they were not mentioned throughout the study. In the next section the researcher discussed how Stephanie views teachers are a part of the learning process.

Teachers and their Part in the Learning Process. Stephanie emphasized that teachers play a critical role in the learning process and influence equity in their classroom learning environments. Stephanie talked about how she needed to take a minute to think through things before she approached a student, so she is accessing the situation correctly. By Stephanie taking a step back she creates a better opportunity for her to figure out what's going on and how to better approach the student. She says that this helps her build better relationships with her students because she can better assess the problem. During the first focus group, she said:

> "So always, like, take a step back myself, before I go over and yell at a kid for having their head down or doing whatever they're not supposed to be doing. I'm like, Alright, take a second deep breath. And then I walk over there. And it's maybe it's just those

> one-on-one conversations that you must have to build that relationship with them, so that they can see they can be successful and will be successful." [FG1]

By Stephanie pausing to assess the situation, she took the opportunity to consider where she and the students are coming from. She understood that students might come from a culture that does not match hers, and she has to be willing to learn about her students and apply that to her classroom learning environment. During Stephanie's final interview, she talks about how gaining a deeper understanding of the culture of her students allows her to make better connections to the content learned in the classroom with the cultural backgrounds of her students. Stephanie said:

> "I would like to know more about different cultures, I'll be the first one to step up and say, I don't know everything about everything, which some people sometimes find that hard to say. And like at our school here, it's so many different cultures and diverse kids in one classroom. I feel like sometimes I need to take a step back and really do my own reading and research. So I have a better understanding about where my kiddos are coming from, and things like that. I think that if I dove a little bit deeper into their cultures and backgrounds, we could, I could see more success and better connections inside the classroom." [I2]

Stephanie taking the time to take a step back and communicate with her students about their diverse backgrounds and where they come from allows her to take what she has learned from her students and infuse it into her classroom practices and pedagogical choices. By doing this, she creates equity. During her first interview, she discussed:

> "What a lot of people and myself we think of equal, but then I take a step back and realize that it's not always equal but more everyone has the same opportunity definitely

> coming from different backgrounds. More people need more support to get that equal opportunity" [I1]

Stephanie emphasized the need for teachers to be willing to access where they and their students come from culturally. To do this, teachers must be willing to have various conversations with their students. These conversations do not always have to be science-related but could be about what they did over the weekend. Having informal conversations allows teachers and students to learn from one another to engage them more during the learning process. One way Stephanie did this involved a cell and organelle structure and function activity for her biology resource special education students. Stephanie brought the organelle structure and function activity as her equity academic artifact. Stephanie started with her examples of comparing the cell parts to people in her surroundings and then had students share their comparisons of cell organelles and their function to family and friends in their lives. Below she talks about how the activity impacted her and her students.

> "…and it actually worked out way better than I was expecting, because the kids got so into it, seeing what their friend shows. And then like why so they were able to see like, maybe a little bit more about the friend next to them or like family dynamics, not like being nosy. But it was fun to share and things like that. And then like I gave my own personal examples." [FG2]

Stephanie used this activity to teach her students about cellular structure and helped bring the lived experiences of students into the classroom. This created a more equitable space because Stephanie used the relationships that students have outside of the classroom and made them relevant to scientific content. To create this kind of equitable space, Stephanie felt that students need to be comfortable in the classroom and create those spaces for them. To create safe classroom

learning environments, teachers must build relationships with their students. Building relationships can be simple conversations, such as asking them what they did on the weekend. During Stephanie's first interview, she said:

> "…by asking them what they do on the weekend. Students describe different events they do on the weekend like quinces. It's important to build the relationships with students. Showing them, we care about them and science and that we just want them to be good humans." [I1]

Students feeling comfortable in the classroom helps them feel confident in what they are engaging with inside the classroom, especially on assessments like quizzes and tests. Frequently, as Stephanie said, students learn something in the classroom, and then it looks completely different when they see it on a test. This year's autonomy to make tests for students allowed Stephanie to use examples and information from her students' cultural backgrounds to assess students rather than using items that look entirely different and unfamiliar for students often found on district and standardized tests. During her conclusion interview, Stephanie said:

> "…I also feel like that also made the students feel more confident. While taking their tests and quizzes and stuff like that, they were able to pull in what we did instead of maybe, county test or whatever. Wording definitely or having like a synonym or a picture that looks completely different than what we've talked about..." [I2]

Although Stephanie did not have a copious number of responses like other participants, she still made her viewpoints well known. She understood the importance of creating a safe learning environment for students and how teachers' practices can impact how classroom environments take shape. Stephanie understands the importance of building relationships with students to open the gateway to incorporating their cultural background into the classroom learning

environment to create an equitable learning space. Even though Stephanie left the study school to teach at another school that might be less diverse, she still wanted to take what she learned about the importance of the culture of her students along with her as she acclimates herself to a new school learning environment.

What was learned from science teachers?

According to Merriam and Tisdell (2016), the purpose of data analysis is to make sense out of the information that participants have offered to the study by consolidating and interpreting what the researcher has seen and heard. A cross-case analysis allowed the researcher to look deeper into the cases. The researcher reviewed each teacher's case to look for themes to elaborate on how teachers conceptualize and build equitable learning spaces for diverse learners in their science classrooms. Several themes emerged from this analysis, including:

1. the roles of teachers in creating equitable learning environments,
2. the difficulty of building equity in standardized science curriculum, and
3. the need for collaborative professional development.

Theme #1

Teachers play a significant role in creating equitable learning environments. According to the teacher participants, the roles are to create safe spaces for students to learn in their classrooms, willingness to build meaningful relationships with their students, and understanding how their cultural backgrounds impact their curricular decisions. Teachers are in classrooms with students every day. Students come with several emotions and cultural backgrounds to school every day outside of just paper and pencil. Sometimes students come to school hungry, angry from an argument with peers or parents, and they also could come to school feeling misunderstood. Dealing and understanding all of these emotions are difficult for teachers to handle, but teachers are

charged with playing more than the traditional role of a teacher in the classroom. Today's teacher does more than teach students content found in standards. One of the clearest understandings of the participants is that teachers play a significant role in creating an equitable space for students in their classroom. Grace, Ashley, and Stephanie pointed out how teachers must create safe spaces to feel comfortable in their classrooms. Also, as Stephanie reported, be aware of when students are not communicating and expressing their ideas and creating a space within the classroom. As the participants learned, sometimes you have to go outside what the curriculum wants you to teach to make meaningful connections with students. One of the artifacts that Grace presented was images of her classroom learning environment.

Creating meaningful connections with students allows the teachers and students to build healthy relationships that allow students to make mistakes and their teacher to help them. Building these relationships with students means that teachers and students learn more about each other, breaking down the barrier between teacher and student. The participants identified these barriers as a cultural mismatch between teacher and student, uneasiness with male teachers, and language barriers. Each person involved in the teacher-student relationship starts to look at and appreciate the various backgrounds and cultural differences among them. Ashley asserted that by learning about the cultural backgrounds of students, teachers could incorporate those details into the curricular decisions made throughout the school year, helping students be seen and valued as part of their learning and not as passive participants. Onwu (2016) stated that the critical objective for science education should be for students to see how science can be embedded in their lives. Students need the opportunity to understand science as it can relate to their own lives and lived experience. For teachers to create scientific experiences that connect to students' lives,

teachers have to make room to build relationships with students. Ashley talked about letting students sit in her class during their lunch periods if they did not want to sit in the cafeteria with all the other students. To keep students from walking the hall and possibly getting in trouble, she opened up her classroom for current and previous students as a safe space during lunch. Ashley opening up her classroom was a sacrifice of her time, and she was willing to make sure students knew that during lunch if they did not want to be around everyone else, they had someplace to come and relax and maybe even have a conversation. By Ashley opening her classroom up, she made room for conversations to be had that usually do not have time to happen during the regular school day. The opening of her classroom space during lunch allowed Ashley space to build relationships with students. Stephanie described something similar, but she did her building of relationships with students during class. She would have students close their computers and have casual conversations about random things by answering questions like "What superpower would you want to have and why?". Doing the work of learning about students and incorporating their cultural knowledge into curricular decisions helps students, as Ashley said, being.

Unfortunately, though many of the teacher participants felt that even though they could put in the work of building relationships and creating safe spaces for students to learn, they felt that it would be pointless because students would still be subjected to standardized testing that would not accommodate to their cultural backgrounds or different cultural experiences. Jordan provided another important insight on teaching English language learners. His problem was more with not having enough time for ELLs to spend with content to get those extra supportive lessons that would allow them to understand science content like physics better. Teachers felt that standardized testing and having a standards period controlled how much time they could spend on content and what content they could teach students. However, teachers like Ashley were still able to

create equitable assessments like choice boards where students could exercise their autonomy in illustrating their knowledge about scientific content. Jordan created an equitable space for his student, although limited when he used a song of the day to connect to an event that happened in science on that particular day. The teacher participants did their best to use what they learned from building relationships with students to create phenomena that explained scientific content and made connections with students' cultural backgrounds. In addition to the teacher participants still being able to work within the standardized education system, they would appreciate more autonomy to make curricular decisions based on the population of students they teach and be trusted to make those complicated curricular choices. For example, some teachers in the study lamented the difficulty of keeping up with the pacing calendar for some populations of students. A way for teachers to use their autonomy would be to give teachers more trust to amend the pacing calendar to fit what would be most beneficial to their students. This does not mean that students won't learn the same content, but they won't have to be charged with keeping the same learning pace as other students, especially if they need more time.

Theme#2

Difficulty of building equitable curricular environments in science classrooms. Throughout the interviews and focus groups, it was clear that most teachers generally knew how to construct an equitable learning classroom environment but found it difficult to build equity within their science curriculum. Most teachers were able to talk about how they integrated equity within their assessment practices and even discussed how they infused equity into their day-to-day decisions but still had a hunger to learn more. Grace discussed how she uses had her students use their primary language when explaining certain concepts to people. Grace also included lan-

guages of other countries written welcome on her walls and lab tables for students to see. However, when discussing assessment. Evelyn also talked about one of the artifacts she brought, which were multicultural pictures of scientists, and she hung them up in her classroom so that students could see someone that looked like them on the way. Jordan talked about how even when he tried to create equitable assessments, it was challenging to make sure they were equitable for all students and not just the majority. Teachers discussed needing some guidance and support to make curricular decisions equitable for all students confidently. Teachers creating equitable classroom environments is a step in the right direction. Teachers can discover more models and integrate equity into the science curriculum, especially for high school teachers. Most studies that focus on creating equitable science learning environments are usually done in middle school classrooms.

It is vital to make the distinction between the classroom learning environment and curricular decisions. The classroom learning environment is the space that teachers create for students to learn in. For example, how teachers group students, decorate the classroom and even greet students as they come into the classroom. Curricular decisions are the teacher's choice surrounding content and, in this case, scientific content. For example, curricular decisions could be how teachers explain keep concepts, what materials are used to teach content, and how teachers assess content learning. During the initial interviews and even in the first focus groups, when participants were asked to describe how they incorporate equity when teaching their students, their examples mainly focused on the classroom's physical spaces. The attention to equitable curriculum did not come until participants were asked to bring their ideas and artifacts that represented both equity in classroom environments and equity in their curriculum.

Teachers said that time was a factor that contributed to this lack of ability to create equity in day-to-day curricular decisions. Teacher participants said that having student populations, such as English language learners and special education students, being bound to complicated pacing calendars that do not always consider language barriers or learning abilities makes having the time to incorporate equity in the day-to-day curricular decisions. English language learners and special education populations need more time to spend with scientific content to have the opportunity to explore and understand the information thoroughly. By holding language learners and special education students to pacing calendars that are hard to keep up with being punished for their differences. There should be more emphasis on professional learning that helps teachers to incorporate equity in their curricular decisions. Also, teachers need support from district and state testing departments that make assessments that honor cultural differences. However, maybe having entities outside of the classroom making assessments is the issue. The power should be left with the teacher to create assessments for their students that honor and celebrate their cultural differences, so they are assets to their learning and not treated as deficits.

Theme#3

_____Professional development focused on equity that acts as a teacher collective. The final clear theme was the need for professional development that focuses on how teachers can be equitable in their classroom learning environment and their curricular decisions. The science teachers at the study school have to engage in curriculum meetings every week. However, during these meetings, as pointed out by Grace, are usually focused on test scores and deconstructing the assessments. During the meeting, people often share strategies, but these opportunities do not come as often because of conversations about upcoming and past assessments. Ashley pointed out how

there needs to be time outside of just curriculum meetings where teachers can really come together and work collectively on activities for the classroom. Everything cannot always be completed in a 52-minute curriculum meeting. Teachers need more time and space. To start developing more equitable classroom assignments, perhaps each teacher should be challenged to present at least one activity that is equitable for all students. The teacher could execute this lesson and report back the highs and lows of the activity. The learning from peers about creating equity both in the curriculum and in the classroom environment should be ongoing. As the last theme pointed out, teachers can identify ways to make their classroom environment equitable but want to learn how to integrate equity into scientific content. Teacher participants are doing an excellent job, like Grace having students describing concepts to each other in their primary language, but teachers want to learn more.

Having professional development that is geared towards equity should operate as teachers being a part of a collective. Teachers working as part of a collective helps them honor each other for their ideas and contributions towards the common goal of creating more equity in both curriculum and classroom learning environments. Ashley asserted that such work would be beneficial if it occurred more often, not just like a box to check off a list of things to talk about within a school year. Teachers participating in meaningful professional development centered around equity is beneficial because teachers can broaden their array of skills to create equitable environments for ALL students and not just the students they teach (Lee & Buxton, 2010). Not fully understanding what equity looked like in a classroom was clear among some of the participants. For example, the participants who offered the most insight into equity in the classroom were Ashley, Grace, and Evelyn. However, in the first interview, Jordan and Stephanie have a hard time articulating what equity meant outside of just being equal.

Most participants had a general understanding but could not go beyond the surface of making sure students have the same opportunity and access to learning as other students. For example, Ashley and Grace showed the most working knowledge of integrating equity into their day-to-day curriculum decisions concerning academic content. However, Jordan, Evelyn, and Stephanie found ways to integrate equity in creating classroom learning environments and building relationships with their students. With the ever-changing ethnic demographic changing in the U.S. schools, it is only appropriate to make sure that teachers clearly understand how to include equitable practices into their work (Swanson, Bianchini, and Lee, 2014).

CHAPTER V DISSCUSSION OF FINDINGS

The goal of this study was to understand how secondary science teachers think about and work to create equitable learning environments for diverse language learners in their classrooms. First, it was essential to understand what each teacher conceptualized as equitable learning spaces to understand teachers' insights. Generally, every teacher participant characterized equitable learning spaces as students having the opportunity to learn. Some participants like Evelyn and Stephanie asserted that facilitators must be aware of the cultural differences that students bring to the classroom and the importance of incorporating these experiences into the learning environment to create an equitable learning space.

Brown and Livstrom (2020) expands on what teacher participants Evelyn and Stephanie asserted about the importance of cultural differences. The study found that when teachers transformed their science lessons to include multicultural connections, they advanced equitable pedagogy in the science classroom. Teachers in the study by Brown and Livstrom did this by doing four main things during the design process:

1. Creating student-centered instruction from student input, for example, by allowing students to choose activities that build off of students interests and experiences
2. Increasing opportunities for collaboration by allowing students to engage in partner or group work and discussions.
3. Integrating cultural and community sources of knowledge by teachers bringing in cultural or language traditions into existing lessons
4. Situating science lessons in a sociopolitical context by providing students with occasional opportunities for action

Even though incorporating cultural experiences into the learning environment is essential, scholars have found that curriculum design is a highly complex process. Teachers struggle with creating relevant cultural connections into science instruction by developing multicultural equitable science education (Suriel & Atwater, 2012). Often, when teachers attempt to develop a curriculum for students of color or diverse student learners, they may have already adopted ideas and deficit beliefs about the expectations of their students that inform their curriculum decisions.

Teacher participants in this study exhibited their ability to make multicultural connections by providing students with learning spaces that included diverse examples of scientists, classrooms with welcoming messages of different languages, choice boards, primary language student chats, and incorporating diverse music to discuss various science topics. The participants were attempting to incorporate students' cultural backgrounds, but scholars like Banks' (2014) would view this integration as superficial because they were not able to reach high levels of multicultural approaches as characterized in a study done by Suriel and Atwater (2012).

The research study done by Suriel and Atwater involved teacher participants being enrolled in a four-week summer science curriculum course that included theories, ideas, and teaching strategies involving multicultural education. The science course was a part of a two-year Master's in education degree program and was required for all students pursuing a degree in secondary science. Topics covered during this science curriculum course included curriculum models, giving voice to students using the curriculum, content of curriculum-making, curriculum relevance, curriculum developers and theorists, history of curriculum in the United States, and multicultural education as it relates to curriculum issues as well as assessment and evaluation of curriculum. Throughout the course, the focus of multicultural education was on the concept of culture, ethnicity, race, their relationship to the science curriculum, and border crossing of diverse

students into the science classroom (Giroux, 1993). Suriel and Atwater's study focused on answering two research questions (a) What were the levels of Banks's typology, and (b) what ideas and personal experiences influenced the level of multicultural integration, especially regarding the teaching of Latino students. To better understand Suriel and Atwater's study is important to break down Banks (1998) multicultural approaches after giving a historical context for multicultural education.

The first introduction to multicultural education was with ethnic studies after the Civil Rights Movement, when African Americans demanded that their historical contributions and possibilities be reflected in school textbooks and curriculum. So, therefore, having ethnic studies was the first phase in the development of multicultural education. Ethnic studies allowed white teachers to easily include content about African Americans' contributions to their cultures and histories by just highlighting their heroic contributions and holidays. This recognition approach challenged white hegemony and allowed White students to understand how their histories and the histories of African Americans were tightly connected. However, the problem with this approach is that teachers would choose heroes that were safe and did not challenge the status quo. Banks (2013) provides the example of how teachers preferred to use Sacajawea, the guide for Lewis and Clark for school lessons, instead of using Geronimo, the apache leader that fought to prevent Mexico and the United States from taking his people's land.

As time went on, teachers and other cultural workers realized that reforming the school curriculum to include ethnic studies also needs to include diverse ethnic and racial groups was necessary but was not enough to actualize educational equality and improve the academic achievements of diverse student groups. These realizations were reflected in scholarship, such as Theory into Practice (DaCosta & McCormick, 1984). Scholars who wrote articles for the Theory

into practice, such as Delpit (1992), Gay (1994), and Ladson-Billings (1995), identified variables of school that needed to be reformed to implement multicultural education thoroughly. The variables these scholars wrote about were school policy and politics, school culture and hidden curriculum, learning styles of the school, languages, and dialects of school, community participation and input, counseling programs, assessment and testing procedures, instructional materials, and the formalized curriculum and course of study, teaching styles and strategies, and school staff: attitudes, perceptions, beliefs, and actions. Theorists such as Delpit, Gay, and Ladson-Billings are referred to as cultural difference theorists because they reject the idea that students of color have cultural deficits. They also believe that schools must change in ways that allow them to respect and reflect the rich cultural strengths of their students from diverse cultural backgrounds. This approach to teaching and schooling is referred to as "equity pedagogy" by C.A.M Banks and J.A. Banks (1995) as well as "culturally relevant" (Ladson-Billings, 1995) and "culturally responsive" (Gay, 1994). All of these theorists support the belief that teachers who use culturally responsive pedagogy are helping to increase the academic achievement of their minority students.

For this study however the Banks multicultural approaches were used because they illustrated levels that teachers could be on while trying to incorporate multiculturalism into their curriculum to make equitable learning environments. Banks (1998) multicultural approaches include various levels, for example, level 1 the “Contributions Approach,” where the heroes and heroines, holidays, foods, and cultural events are celebrated occasionally in the classroom; Level 2 the “Additive Approach” where content, lessons, and units are added to the curriculum without changing its structure, for example adding the contributions of Black and female scientists to the already existing science curriculum; Level 3 the “Transformative Approach,” when the core of

the curriculum has been changed to include various perspectives of diverse cultural groups so that students can engage and experience concepts, issues, events, and themes from multiple perspectives; and Level 4 the “Action Approach focuses on students making decisions related to significant personal, social, and civic problems, so they can then solve them.

Suriel and Atwater's findings were comparable to a study done by Vavrus' (1994), stating that the integration of specific multicultural techniques and strategies in a multicultural course allowed some participants to develop a multicultural science curriculum at higher levels of Banks' multicultural approaches. In Vavrus's study, he researched how student teachers' presented in the classroom according to Bank's (1998) multicultural approaches. The results of this study suggest how the move from level 1 to levels 3 and 4 of Banks's multicultural approaches would happen as teachers develop lessons with multicultural content. One of the biggest implications from this study is the need for a multicultural foundations course in teacher education. The emphasis in this study was also that multicultural foundation courses cannot just be done in a silo. Still, multicultural education needs to be ongoing to help increase the possibilities for multicultural content by teachers.

Overall Suriel and Atwater found that when participants were able to experience life as a cultural “other” by doing things like going abroad to other countries and receiving targeted instruction in multicultural curriculum design were better able to design the most integrated multicultural and equitable science curriculum. The teachers that reached more advanced levels of Banks’ multicultural approaches were willing to do the work of experiencing life as a cultural “other” and gaining a different perspective that allowed them to be more reflective and create more of a multicultural science curriculum. As Suriel and Atwater along with Vavrus highlight,

a multicultural curriculum is complex but necessary to adapt to the increasingly culturally diverse classrooms. Also adapting classrooms for diverse learners aligns with the recommendation from the National Academy of Sciences that the current education system needs to take stock of the science content and practices that teachers use to support the learning of a range of diverse learners (National Academies of Sciences, Engineering, and medicine, 2015).

Even with recommendations from the National Academy of Sciences to better educate teachers to adapt their classrooms to accommodate and advance diverse learners, teachers are still struggling. In this study's participants the struggle to craft equitable learning spaces for students and their ability to extend beyond levels 1 and 2 of Banks' multicultural approaches is evident. The teacher participants in the researcher's study are attempting to develop equitable learning environments through a multicultural curriculum. The participants made attempts by giving students safe spaces to express themselves, welcoming a student's primary language as an asset in the classroom learning space, as well trying to make cultural connections to science through music. Although they are trying to incorporate equity their efforts did not move far beyond their classroom aesthetics and additives throughout their curricular decisions.

Teacher participants struggled to present and explain how they were building equity into their classroom learning environment to include cultural connections in their scientific content. Teachers' understanding of how to incorporate culture into their classrooms from the molecular to the broadest level is essential for students because the influences of culture and a student's environment impact what takes place in the classroom (National Academy of Science and Engineering, 2018). However, as Huang, (2004) assert teachers have limited knowledge and skills on how to develop inclusive multicultural curriculum beyond their physical classroom spaces that would help them to construct equitable learning environments in science much like the teachers

participants in the researcher's study. Huang did a case study on how new immigrants in a science class were able to develop their academic writing through a content based writing program. It was through this study the researcher learned that teachers need more professional learning to help to develop skills to teach diverse leaners.

The participants mainly characterized students' access to equitable, culturally inclusive learning environments through their classroom aesthetics and some of their curricular decisions. The majority of participants shared how they made equitable environments through nurturing supportive student interactions, like having students check each other for understanding and using their primary languages to understand scientific concepts. Examples from other participants included using family relationships to have students make connections with the functions of organelles. The researcher found through interviews and focus groups that the application of equity through multicultural science education needed help and more development. Building equity in science classrooms through multicultural education is rooted in cultural pluralism (Nieto, 2018). It shows there is more than one perspective in how students can learn and view the world around them, and it is necessary for democratic education in the U.S. As Mensah and colleagues (2018) asserted, most teachers view creating multicultural education as staying within levels 1 and 2 of Banks' multicultural approaches. To improve the ability to develop their knowledge and practices, teachers need support. When teachers engage and create curriculum materials, they select, interpret, and adapt materials based on what they think meets the needs of students. Brown conceptualized these decisions as a teacher's pedagogical design capacity (PDC) (2009). The pedagogical design capacity is how teachers engage in the design of activities by perceiving and mobilizing existing resources to make instructional units (Pea, 1993; Ball & Cohen, 1999; Brown,

2002; Brown & Edelson, 2003; Brown, 2009). Developing this capability for teachers is a challenging endeavor.

Science teachers that build multicultural science curriculum engage in curriculum design that is complicated because frequently, teachers have to substantially modify existing resources or create entirely new lessons (Brown & Livestrom, 2020). During the design process, science teachers need to design materials that contain rich community connections that may not have an explicit science focus. Science teachers have to expand their PDC to incorporate the cultural experiences of their students. In Brown and Livstrom's study showed that increase in multicultural content using Banks' multicultural approaches significantly increased their ability to integrate culture into their content. The teachers in this study did this by creating student centered content, increasing opportunities for collaboration among students, integrating cultural community sources of knowledge, and situating science lessons within sociopolitical contexts. All of the curriculum design can be an overwhelming task, especially for novice teachers like the teachers in this study. As previously mentioned, generally, teacher participants were able to build classroom learning environments that were welcoming to multicultural education through building relationships with students and expanding the view of science. However, teachers needed to engage in professional development to broaden the pedagogical design capacity (PDC) to build equitable multicultural classrooms. In the following sections, the researcher discussed several issues arising from the analyses conducted for this study, including the importance of building relationships, expanding the view of science, and the need for targeted professional development to help teachers design multicultural science curriculum to create equitable classroom learning environments.

Building Relationships with Students

Participants constantly asserted how teachers must be willing to address the needs of the 'whole child', not just the parts of the student they relate to culturally or feel more comfortable with. For example, Ashley and Grace discussed the conversations they would have with students that were not always about their grades or academics but focused on the mental health of their students. They did this by genuinely asking students daily how they were doing and challenged them to elaborate instead of keeping their remarks surface level. Through these conversations, Grace was able to learn the cultural norms of some Hispanic students finding it disrespectful to look teachers in their eyes. Before, Grace thought students were disrespectful, but after this interaction was able to gain better insight into the behaviors of some of her students.

A study done by Gerdin and colleagues (2020) pointed out that building relationships is a foundational element of building classroom equity. Building relationships with students encompasses more than just knowing their names but learning about their family structure and interests. This study asserts the importance of focusing on building relationships and understanding the social inequities that students face every day. Meeting the needs of the whole student requires teachers to be willing to build relationships with students so that teachers and students can work together to approach the students' needs. Gerdin's study did not provide concrete examples of strategies to build relationships, however other studies have endeavored to do so.

An article by O'Ferrall and colleagues (2010) point out strategies to help teachers build relationships with students and how building these relationships promotes change. Some strategies include building empathy, admiring negative attitudes, and leaving the ego at the door. As Adler (1956) says, most teachers see empathy and caring as the same thing; however, Adler points out the differences with characterizing empathy as "seeing with the eyes of another and

hearing with the ears of another and feeling with the heart of another." Being empathetic is vital for teachers because it forces the teacher to step out of their reality and see different experiences from the viewpoints of their students. Admiring negative behaviors is another approach that is helpful to building relationships with students. When teachers admire students' negative habits, they use positive psychology to look at the negative behavior as something the student has been practicing for a long time and redirects the negative focus to something the student can use in the classroom. The example that O'Ferrall and colleagues (2010) used of a manipulative girl that could be disruptive to the classroom, instead of engaging in a power struggle, her teacher could reframe the students' behavior as an essential skill that can be applied with sincerity in the classroom or her future career. The final way the article discusses how to build relationships with students is by leaving the ego at the door. Teachers and administrators need to engage in this practice when engaging with students to leave their impulses, issues, and adverse reactions at the door before talking to students. For example, one of the teachers in this study, Stephanie, talked about how she needed to check herself before talking to a student to be cautious that she is not deflecting negative attitudes upon her students before thoroughly assessing the situation at hand. As discussed by O'Ferall and colleagues, teachers engaging in all the aforementioned behaviors helps provide avenues to help them connect to their culturally and linguistically diverse students.

Ashley, Grace, and Stephanie spoke most about how they found it necessary to build meaningful relationships with their students. One of the most prominent examples presented was by Ashley and how she gives her lunch period to provide a space for students to give them space to feel comfortable talking to not just her but each other. She uses this time to get to know her students and to understand their lived experiences. Creating this bond with her students helps her create a space where her students feel comfortable coming to her and expressing when they need

assistance. They also learn that their teacher cares about their academic needs and their social and emotional needs. Other participants like Stephanie talked about using random questions to ask her students, like “If they could have a superpower, what would it be?” to understand her students’ different perspectives. Even though Evelyn did not explicitly talk about how she built relationships with students, she did show agreement to statements that the other participants made. However, Jordan, the only male participant, did not contribute any insight into how he built relationships in his classroom learning environment. Jordan overall mainly focused on the language of his students and saw their language as a possible hindrance to their learning and understanding of scientific content. Jordan characterized activities that build relationships with students as mushy activities that are easier for female teachers to participate in. Participants spoke about how they create and build relationships with their students but did not discuss how they use the information they learn from their students as a factor in their curricular decision-making outside of classroom assessment practices.

Building meaningful relationships with students and getting to know the whole student allows the teacher to help students make meaningful connections with science content. For example, McNeill (2008) studied how particular curriculum supports helped students write scientific arguments to explain scientific phenomena. The study involved teachers who conducted an eight-week chemistry curriculum to support their students in inquiry practice, constructing scientific arguments and justifying their claims using evidence and reasoning. Out of all the teachers involved in the study, the teacher who helped her students make the most gains in scientific explanations and content knowledge used students’ prior knowledge and cultural experiences to guide many of her instructional practices. Students used examples they generated to define evi-

dence as “the data you have from actually doing something” and what counted as sufficient evidence. According to McNeill (2008), the type of conversation in Ms. Nelson’s classroom was unique. The teacher took a back seat to conversations and let her student take ownership to work through their thoughts on critiquing scientific explanations. The study concluded that the interactions between teacher and student in Ms. Nelson’s classroom allowed her students to make more significant learning gains through providing support and creating a culture with different classroom discourse norms. Other studies conducted by Lee and colleagues (2003) used a cultural modeling approach to engage students from non-dominant backgrounds by guiding them to connect their own cultural experiences with the content being taught. Lee and colleagues did this study with African American students to encourage them to apply their understanding of everyday narratives with narratives they were familiar with, like hip-hop lyrics, to the reading material presented in class. Connecting everyday cultural practices to classroom practices, students became more comfortable with learning objectives and felt like they had access to the information taught in class.

Another way that researchers showed how teachers make connections with the cultural knowledge of their students to the content is through constructing a third space (Gutierrez et al., 1995). Third spaces are co-constructed with teachers and students to allow students space to share and elaborate on their narratives in a larger classroom space (Gutierrez, 2008; Gutierrez et al., 1995). Third spaces are crafted to capitalize on the links between the students' funds of knowledge or the discourses that students bring to the class with the dominant discourses valued by schools (Moje et al. 2004). A study done by Moje and colleagues on middle school science classrooms showed that students' funds of knowledge are valuable to the classroom setting and that these funds of knowledge need to be encouraged and drawn on within classroom contexts.

Funds of knowledge are grounded in the students' membership and experiences outside of school in the worlds they inhabit (Gonzalez & Moll, 2002). For example, the study on funds of knowledge and discourses in a hybrid space done by Calabrese Barton and Tan (2008) used students' funds of knowledge in family, community, peer, and popular cultural funds and Discourses. Moll and colleagues (1992) did a study where they analyzed how the funds of knowledge represent a positive view of households as containing ample cultural and cognitive resources that have great potential for utility in the classroom. Each teacher participant chose to study three households of children in their classroom to visit and observe and interview their families within a semester of study. Through this study, Moll and colleagues realized how useful it is to have teachers visit the homes of their students for research purposes. Having meetings or interactions with families outside of the classroom helps the teacher establish the learner's role and develop more balanced relationships with the parents of students. With the new relationship between teachers and student families, there was an exchange of knowledge about family matters or school matters that could contribute to the academic content and lessons.

For example, in a study by Moje and colleagues, they used a student's funds of knowledge about their parents' work outside of the home. As they discussed the air and water quality unit, students mentioned how their fathers worked as landscapers or farmers when talking about information about water quality. Then the researchers used that as a bridge to discuss why water quality would be essential to understand. Students were then able to use their fathers' work as landscapers and farmers to understand how water quality might affect the work their fathers do, and further involving the economic importance of following the processes and the protection of the investment of plants. As the researcher pointed out, this particular fund of knowledge had a global quality because as the researchers interviewed students, they found that the science of

the curriculum was able to surpass the local community of students and extend to family relationships that crossed state and national boundaries. Using the funds of knowledge in this particular example allowed the teacher to reach Banks level three of multicultural approaches because her students were able to make connections between their own culture and various perspectives of other students to extend their understanding of water quality.

Studies have shown that a student's culture is a valuable asset to the classroom learning environment, and building relationships makes room for students to feel comfortable expressing themselves and sharing their lived experiences with their teacher Moje et al. (2004). With this valuable information, teachers can then help students connect to scientific content and, for example, engage in activities like scientific writing and argumentation. Studies show that connecting with your students to understand their funds of knowledge better is not a “mushy” activity but a necessary action to help teachers develop content that can draw on and make connections with their students’ cultural background (Calabrese Barton & Tan ,2008 ; McNeill, 2008; Suriel & Atwater, 2012). Learning should be shared among teachers and students and not just teacher centered. Several of the studies described above demonstrated how teachers allowed their students to be meaningful participants in their learning through the relationships they built, thus enhancing and creating an equitable classroom learning environment. When teachers build relationships with students it fosters the environment for students to be an essential part of their learning. To create an environment that encourages the building of relationships with students, teachers also must create a safe space for learning both emotionally and academically.

Safe Spaces for Learning

Building relationships with students can only occur if students feel safe in their learning environments and with their teachers to share personal things about themselves and their lives.

According to Goldstein (2005), safe spaces promote safety and a learning environment free from violence and allow educational experiences. Violence does not always have to be physical, but rather emotional violence. According to Goldstein (2005), when classrooms do not consider the students' social and emotional needs, this lack of connectedness, along with other systemic violence perpetrated against young minds and bodies, can have students thinking that they do not understand and distrust their own needs. Students should feel safe being whomever they are and have space to share their opinions and not be ridiculed by their peers. This is not to say that everyone should agree with their experience or opinion. Safe spaces need to be created for students where their differences are respected and norms are created for the intellectual safety of all students. Boostroom (1998) and Holly & Stiener (2005) assert that students learn in an environment where they feel empowered to take risks, share their insights, and know that it is ok to disagree with others' points of view. The participants in the study continued to emphasize how important it was for students to have a safe space to learn in. Grace created a safe space in her classroom when she would read in the primary languages of her students. She showed her students it is ok to make mistakes and empowered them to feel comfortable taking risks. Ashley also created a safe space during her lunch period because she gave students space to come so they wouldn't have to fear eating lunch by themselves. Ashley gave them the freedom to assemble and fellowship with each other and herself.

Creating a safe space for students to learn is key to building equitable spaces within a science classroom. When teachers create a safe space that holds each student's being and perspective as valuable, they foster an environment to engage in multicultural education that exhibits the views and understandings of science from the various perspectives of students present in the room. There are many aspects of science. There is room to discuss and get a different opinion

from various student cultural backgrounds and opinions that might conflict with one another to get different discourses than what is already readily available for students in their content standards (Mayo, 2002). The difference of opinion is hard to discuss among students if there is no safe space within the classroom. For example, students reading in class can sometimes feel scared to do it aloud when they are unsure about their English sounds. Grace made sure to encourage students to read aloud and made sure that other students knew that it was not ok to make fun of anyone because they sounded different.

Creating a safe space for students gives them opportunities to engage in socio-scientific issues, which has been looked at as a development important to scientific literacy. Students can engage in socio-scientific conversations when they have deliberate conversations about authentic problems and become active participants in decision-making (Zeidler et al., 2019). Having students engage in socio-scientific issues is one way to have teachers develop their curriculum to reach level 4 of banks multicultural approaches that allow students to solve problems in the world around them. Although none of the teachers spoke specifically about how they have deliberate conversations that engage socio scientific issues , teachers like Ashley and Grace fostered an environment for their students where these type of learning experiences could potentially happen. Safe spaces in science classrooms foster an environment for transformative multicultural education to happen. However, teachers still need support in making these pedagogical decisions through the help of participating in professional development to work as a collective towards these goals.

How Race Factors into Building Relationships with Students

An African American female teacher-researcher conducted this research study. All of the participants in this study were self-identified, white individuals. Conducting this research study was interesting because the researcher was an African American woman discussing with white educators about creating equitable environments for culturally and linguistically diverse students. Through the entire research process, the researcher learned how to facilitate conversations concerning the equitable treatment of the diverse needs of the diverse learners present in their classrooms. For the researcher, the conversations were not difficult, but the researcher approached each interaction as an opportunity for the participant to learn from the researcher and from the researcher to learn from the participant. Throughout the study, both participants and the researcher discussed the importance of students and teachers building meaningful relationships. For some participants, this was difficult to do because of the cultural mismatch.

The race of teachers and students plays a vital role in how relationships are built in the classroom and how students' assets are viewed and valued in the learning environment. Currently, teachers of color or (TOC) represent 20% of the U.S. public school population, while students of color represent 52% of public-school students (McFarland et al., 2018). This disproportion roots back to Brown v. Board of Education (1954), when schools were desegregated. When schools were desegregated, this caused African American teachers to be deemed unfit to educate white children. Therefore approximately 38,000 African American teachers lost their jobs in southern states in the U.S. over ten years. Policies such as Brown v. Board of Education show how federal, state, and local-level policies and legislation support the anti-diverse, non-critical race practices within the United States education system.

Having a diversified teaching staff is essential. Recruiting and retaining teachers of color requires that stakeholders pay attention to structural, institutional, and environmental factors in schools and teacher education programs that keep teachers of color out or push them out of the teaching profession. Representation of teachers of color matters in the teaching profession because they can boost the academic performance of students of color by enacting more culturally relevant teaching practices, having more positive perceptions of students of color, and helping them feel more welcome in the school environment. Having more teachers of color in the teaching profession overall acts as a medium to help sustain the culture and knowledge of their students of color and enhance the sociopolitical consciousness of all students (Carter et al., 2019).

Teachers Working as a Collective in Equity Focused Professional Development

The second finding from this study concerned the need for teachers to see students within their content group, for example, every student who learns biology, belonging to every teacher who teaches biology. Having every student belonging to the group of teachers helps them work together with a collective mindset. Then, teachers can work together to create equitable learning environments for students in their classrooms. One-way teachers can collectively work towards equity is to be engaged in collaborative professional development. Having professional development that focuses on infusing equity as a goal for the group of teachers can be a tool to support their work together, giving them opportunities to converse with peers, present and defend ideas, and exchange diverse beliefs. (Laal & Laal, 2012).

Currently, in the study school, science teachers have to meet with their content group once a week to discuss mostly issues centered around testing and how to get students to score better on a particular concept in their assessments. Grace often asserted during the focus groups

how the current model that exists for her weekly curriculum meetings is not beneficial to the advancement of students' learning. Grace also stated that teachers need to view students as belonging to everyone and not just a particular teacher. By having this mindset switch, she feels like teachers are able to put all their talents together to help work towards the goal of helping students gain a better understanding of scientific content. Ashley also discussed how she wanted to have more ongoing professional development. She described how teachers are paid to come into the building before every school year to work on their assessments for the upcoming year. However, after this allotment of time, there is no other time for teachers to come together and work collaboratively outside of weekly curriculum meetings. Ashley suggested that there needs to be more opportunities throughout the school year for teachers to come together and, as Grace pointed out, work as a collective to create materials for students that are equity focused. However, the space and opportunity has to be created for the teachers in the study school to have time to work towards this goal of equitable learning for all students. Even though there are weekly curriculum meetings that happen where teachers of the same content meet, participants like Ashley and Grace expressed that during these meetings, more time is spent going over questions for assessments than strategies and models to build equity in the curriculum through multicultural education. Time spent going over test questions can take over the meeting, and then there is almost little to no time left for teachers to share strategies. An equity-focused professional development program (PDP) can accomplish this goal of more equitable instruction through multicultural curriculum. Teachers can meet to discuss making their curriculum more inclusive and welcoming to different cultural backgrounds (Sleeter, 2011).

Apparent in the legislative legacies of Brown v. Board of Education (1954), the Individuals with Disabilities Act (IDEA, 2004, 1997), and the No Child Left Behind Act (NCLB, 2001)

was that inequitable opportunities in education exist within the United States educational system. Professional development programs that focus on operationalizing equity in science teacher interventions help teachers use instructional practices that facilitate diverse student communities' access to science learning (Bancroft & Nyirenda, 2020). Some of the characteristics of effective features of professional development, as asserted by Bancroft and Nyirenda, are content-focused, coherence, collaboration, and duration. Generally, Bancroft and Nyirenda believe that professional development should be focused on the context of the students in the teachers' classroom, they should align with content standards that improve teachers' knowledge and skills, teachers should collaborate to develop new understandings of classroom practices and should requires sufficient time for teacher beliefs about effective instructional practices to be transformed. The same characteristics of effective professional development are also necessary when teachers are engaging in equity-focused professional development. Pena and colleagues (2006) also assert that having an equity focus on education helps to teach students from an asset viewpoint rather than a deficit viewpoint.

Teachers engaging in equity-focused PDPs also helps expand the horizon of equitable classroom learning environments past the physical classroom space. Adequate equity-focused PDPs immerse teachers in discipline-focused firsthand experiences that model ways to continually assess student knowledge of science concepts and invite students' home lives into communicating, thinking, and doing science (Bancroft & Nyirenda, 2020). While doing this, teachers' are-also be able to use appropriate cultural artifacts and community resources that situate new science concepts and skills (Lee & Buxton, 2010; Sleeter, 2011). Another critical factor of adequate equity-focused PDP is the need for the PDP participants to work together with the PDP developer and other colleagues to make sure that individual needs are met (Loucks-Hoursley et al.,

2010). Everyone involved in the PDP working together to meet each other's needs allows peers and experts to develop a new understanding of classroom practices (Anderson, 2002). By everyone working together, they are held responsible for each other's learning to gain a better understanding from being a part of the PDP, and therefore working as a collective.

Buxton and colleagues (2015) worked with middle school science teachers in a three-year study focused on supporting multilingual learners. They engaged in a professional learning project entitled Language rich Inquiry Science with English Language Learners (LISELL). The goals of the LISSELL project was to develop and test a pedagogical model the facilitated the development of a set of language of scientific investigation practices for all students with particular attention to emerging bilinguals. The researchers also wanted to test how teachers participated in and used the multifaceted teacher professional learning framework and how they took their own ownerships of the LISSELL pedagogical model. The LISSELL pedagogical model was developed with the goal to prompt students to have science talk,, writing, and action in ways that would increase bilinguals students access to science while supporting practices that were central to scientific investigations. Teachers' in the LISSELL professional development participated in a summer four-day teacher institute, classroom observations, bilingual "Steps to college through science" family workshop and exploring student writing workshops. Throughout the study, teachers asserted that the professional learning activities of LISELL satisfied an unmet need in their schools for help to provide explicit support for their growing number of bilingual learners. Much like the researcher's study school, this is a group of students continuing to grow in classrooms across the country. However, teachers are not receiving targeted help to develop and transform their classrooms into a multicultural curriculum.

Teachers engaging in equity-focused PDPs helps them see all students as learning and doing science (Loucks-Horsely et al., 2010). In a collective teacher group, everyone is responsible for the learning of everyone in the group. The success of one learner helps all the learners involved be more successful in accomplishing the goal of learning and engaging in more equitable classroom practices the engage learners in a multicultural curriculum that exceed level 2 of Banks multicultural approaches (Gokhale, 1995). For teachers to work together as collective other stakeholders in education must value the need for educators to gather often to discuss and work towards equitable spaces in their classrooms. As Ashley stated, there is no time dedicated to teachers working together to create equitable student resources throughout the year.

To put more value on the need for teacher professional developments, stakeholders need to make more room within the school year for these teachers to gather and solely work on equity-focused PDPs. Penel and colleagues (2007) assert that most professional development activities are designed to be too short and do not give teachers more opportunities to follow up once they begin to teach or implement what they have learned. The National Academy of Sciences, Engineering, and Medicine (2020) reported that even though most teachers have access to professional development, the opportunities were uneven or underdeveloped in areas like teaching science to students with special needs or supporting diverse language learners. The same report also said that teachers are usually given professional development that is content focused and professional development to support diverse student learners is separate. Teachers need to be a part of ongoing professional development that focuses on how to change their possible deficit perspectives regarding their diverse learners' abilities to engage in and understand STEM subjects (Buxton et al., 2015).

Allowing teachers to work collectively towards building equity in their curriculum and classroom environments helps them show students how science functions in their lives every day and even possibly as a career choice. Teacher participants like Grace and Ashley spoke several times during the focus groups about how they often used each other as resources to learn different ways to present and engage students in different scientific concepts. Grace typically teaches English language learners, and Ashley teaches "on-level" (college prep) students and honors students. These two teachers exchange resources to ensure success and access for all students to chemistry content. They are working together on a small level; imagine the possibilities if all teachers within their content group operated with that same collective framework. A study done by Loughland and Nguyen (2020) on the use of teacher collective efficacy as a conceptual framework for professional learning, used collaborative planning, in- the-action mentoring and reflective discussions as a whole group to promote and enhanced collective agency among teachers.

Having teachers work together towards equitable classrooms through building multicultural curriculum materials helps support teachers who need more help in their understanding and learning of equity from other colleagues who might be more expert in the subject (Ball & Cohen, 1996). When teachers work together in this capacity, it helps to build trust in a school building and allows leaders and teachers to have more discretion in making difficult decisions along with creating the more explicit role of obligations and sustains a commitment to student outcomes (Frank, Zhao, & Borman, 2004).

Expanding the View of Science

The last significant finding related to how participants felt that creating equity within their science classroom learning environment helped students see science as more than a school

subject. Creating an equitable space for students helps them see how science functions both in their lives and as a career choice. A clear example of helping students see how science can be a career choice is when Evelyn, one of the Forensic science teacher participants, had her students work on forensic science career posters. There are few opportunities for students to explore career choices within the science curriculum, but Evelyn frequently makes room for this exploration throughout the school year. Evelyn's forensic science curriculum group also brings in guest speakers from the various forensic science careers, for example, having a mortician come in and discuss his career when we talk about the body as evidence. Evelyn also highlighted that one of her curriculum members which is African American always wanted to make sure that guest speakers were someone of color as to make more of a cultural connection to students. What Evelyn and the other forensic science teachers are doing still registered on level 2 of Banks multicultural approaches. It is a good start, but activities can be further developed using equity-focused professional development. The goal for equitable multicultural instruction is to be transformative.

McDermott and Weber (1998) point out how a significant goal for science education is to provide all students with the background to be investigative of personal and community priorities. Students should have the ability to frame scientific questions about their interests, conduct investigations, and communicate their scientific understanding and arguments to others. Creating an equitable space encompasses integrating as many parts of the student as a teacher can into the curriculum so that students can see science as a possibility. Expanding students' view of science helps promote scientific literacy to give students a macro and micro view of how science impacts their communities and the worlds around them on a macro level and their individual person on a

micro-level (Laugksch, 1999). The purpose of diverse learners understanding and applying scientific concepts to different situations is not just to ultimately be a part of a STEM career but to function in ever changing society where it is essential to understand and participate in a scientific society.

Students need to see that those actions they do every day are related to what scientists do. For example, during the focus group, Grace said that her kids are very observant. Many of her students also know how to work very well with their hands in their jobs outside of school, like being a mechanic or fixing household appliances. Grace connected in the focus group how she expresses to her students how them being very observant about their surroundings is compared with how scientists must be very observant to understand and explain scientific phenomena. Also, how students that are great at using their hands could pursue a career in engineering. Building an equitable space in the science classroom helps students understand scientific concepts concerning their person and their attributes as characteristics of a scientist (Faller, 2018).

The decisions teachers make when they interpret their students' attributes and cultural experiences as an asset to their learning can affect how students see how science functions in their lives and their participation in science as a career. A study conducted by de Araujo, Smith, and Sakow (2016) found that teachers of diverse learners still need to critically examine the potential impact of their beliefs about their diverse students. Teachers within the study overlooked how a diverse language student should be seen as a tool rather than an obstacle to their learning. One of the recommendations from this study is to have teachers participate in professional development that focuses on teachers confronting the beliefs they hold about the abilities of diverse learners. After identifying the deficit thinking teachers have about diverse learners, the next step would be to engage in professional development that challenges those beliefs. Teachers' beliefs, such as

diverse learners not understanding science or their cultural backgrounds being a deficit to the learning and how they form their classroom space and develop their curricular choices impact the trajectory of their student's involvement in science and possibly a STEM career. Suppose teachers do not do the work to challenge their beliefs. In that case, they negatively affect the trajectory of students seeing themselves as a part of the scientific community and then impacting how they might participate in the scientific community to advance their cultural communities (Banks et al., 2007).

Boundaries of the Study

This study was bound because of the limited number of participants involved in the study. The study was not designed to be generalizable. Expanding the study to include participants from another school would provide more information about how teachers conceptualize equitable learning spaces in different school climates, which would expand the study boundaries. The school district's Institutional Review Board (IRB) halted the participation of other teachers from various schools. The district IRB felt that having teachers outside of the researcher's school would be a distraction and another hindrance for teachers to do their job in conjunction with the circumstances of teaching during a pandemic. The study could have also benefited from more focus groups. However, the researcher did not want to burden the participants with too many more virtual interactions outside of the typical school day that already included a full schedule of concurrent teaching. The researcher feels that going forward, more focus groups and interviews could have been conducted to understand how teachers implemented their work towards equity hopefully. The pandemic also impacted the researcher's ability to conduct classroom observations because students are mainly online on digital platforms and not in a physical classroom.

Even though mentioned earlier, it is essential to acknowledge how much of a boundary to the study the Covid-19 pandemic was. The pandemic heavily impacted the 2020-2021 school year. Students were primarily engaged in virtual classroom learning mediums and platforms. Teachers were also bound to teach students virtually and in person, which revealed a new phenomenon called zoom fatigue. The pandemic also had some impact on how all teachers interacted with other teachers and students. With all of this information and the researcher being a teacher herself, the researcher had to alter the study to fit inside the new normal that the Covid-19 pandemic school year presented. However, as the findings report, teachers in the study still found ways to communicate with each other and their students. Finally, the pandemic impacted the researcher's approval in doing the study at two schools versus one school because the district's IRB did not want teachers to be affected in any other capacity than how they were currently being affected by the circumstances brought on by the pandemic.

Recommendations for Future Study

A decision that would be beneficial during replication of the current study would be to add observations. The participants were responsible for self-reporting how they built equitable spaces in their science classrooms. Observing how teachers interact with students and how students interact with teachers will be beneficial because the researcher will gather more data on how the teacher participants are building relationships with their students. Observations would also be helpful in seeing how teacher participants engage students in intentional equitable curricular decisions. The researcher is also interested in seeing student reactions as they engage in equitable curricular decisions.

Another possibility for the future research study would also be to expand the participants from just teachers to other participatory stakeholders involved in the curricular decisions for students in science classrooms. These participants should include department chairs, curriculum assistant principals, and the assistant principals over the special education and English language learners. Expanding participants will help the researcher understand how their choices impact how their teacher colleagues build equitable learning environments. More data sources will allow for better triangulation of data.

To also add to the study, the researcher would like to have the participants engage in a targeted professional development that identifies the teachers' beliefs about diverse learners and then craft activities that help teachers challenge their beliefs. Before the first focus group participants were given reading material where the goal was to help broaden or strengthen the participants understanding of how equity functions in the classroom. During the first focus groups most participants expressed how reading those articles really helped them to expand their definition of equity and also show them that they were already engaging in equitable practices. Perhaps having teacher participants read articles on the influence of teacher beliefs in crafting multicultural curriculum will then spark an important conversation during the following focus group. Also, during the professional development, teachers will take their existing activities to work towards more transformative multicultural approaches to their pedagogical choices. The existing articles that teachers read were helpful to participants to really see how equity functioned in their classroom and then went further by giving them key examples of what the strategies were that made equitable classroom environments. For the next study the researcher would give them Banks' multicultural approaches and also another article that shows how these approaches could be mo-

bilized in their classroom. The article reading would be followed by a collaborative group discussion where participants could reflect on the information they just read and how it could inform their teaching. As the scholars who have done work on professional development collaborative discussions assert how addressing teacher belief is important so that teachers can identify their own thoughts and ideas and then get perspectives from other teachers as well. (Suriel & Atwater, 2012; Laal & Laal, 2012).

Finally, another approach to engaging teacher participants in collective professional development about equity would start with teachers identifying what do they hope to get out of the professional development or what are some skills they feel they need to better develop to create equitable learning environments. Having participants start with identifying their goals helps to guide the trajectory of the professional development so everyone such as the facilitator and participants are clear about what everyone wants to accomplish. Identifying these goals at the beginning will allow all involved in the professional development to help each other better, because there could be a range of competency levels about equity. Being able to identify the people that are on the different competency levels of equity within a collective of teachers will allow space for teachers to work better together. Once identifying goals and the competency levels of individual participants then the participants could continue by engaging in the activities previously mentioned. In this collective professional development participants can use their varying competency levels of equity to help transform their lessons that could only be on level 1 or 2 of Banks multicultural approaches to help them reach level 3 and a possible level 3.

One of the goals as the professional development facilitator would be to help teacher participants to transform their lessons past level 2 of Banks multicultural approaches. One way this can be done in chemistry is through a combustion lesson. Typically, teachers describe the act of

combustion in chemistry through describing a phenomenon of a campfire. Using this example is not always accessible for some diverse students, because they are not familiar with a campfire. One way science teachers from this study transformed their lesson to reach level three of Banks multicultural approaches was to use a more accessible phenomenon such as fireworks. Their students were way more familiar with this, the teachers then extended the connection by having students use the flags of their countries and the countries of other students. Students were tasked with using the color in a particular flag from country to describe what elements from the periodic table would make fireworks to show the colors of their particular country. The key elements that helped to extend this activity from level two to a level three of Banks multicultural approaches was that instead of the teacher just including other culturally responsive examples of combustion in relation to a camp fire, they decided to include different perspectives of other ethnicities by incorporating the flags of other countries. Students were encouraged to not just use their countries flag, but the flags that represented other students' nationalities.

When students completed this activity, and the teachers hung the flags with the equations for the fireworks outside their rooms one teacher made the comment about how she had to move one flag from another because they were feuding countries. A way that this teacher could have took this issue and expand on her activity to reach level four was to discuss with students or get their perspectives on why countries with similar flag colors don't get along. Level four encourages a social action approach that strives for social change. Discussing this issue in a class setting would give students a chance to discuss this problem of conflicting countries and possibly find ways to resolve conflict.

Implications

Going forward a question that this research study draws is what white teachers can do to create better equitable learning environments for diverse learners. From the participants it can be gained that white teachers need to simply be empathic and take time to build meaningful relationships with their students. Teacher participants such as Ashley and Grace really showed how they made it a priority to make sure all aspects of their students felt welcomed in their classrooms. Ashley created safe spaces for students during their lunch period to just come to her room and chill and talk or not talk. Hope also tried to make her classroom a non-monolingual environment by making her space welcoming to all languages of her students. Another important piece to what white teachers can do to create equitable learning spaces for their diverse students is to not view their cultural background or language as a deficit to their ability to be successful in the school setting. Before any of the creating equitable learning spaces for students can happen though white teachers have to be willing to look at their own beliefs about diverse learners and how they think the diverse backgrounds of students can or doesn't operate in the classroom. Once white teachers do the work of addressing their own beliefs they can begin to create beneficial equitable learning environments that are able to reach levels two and three of Banks multicultural approaches.

Conclusion

The U. S school system is diverse and will continue to be that way (National Academies of Sciences, Engineering, and Medicine, 2018). Students' cultural differences should be acknowledged and respected in the classroom as an asset and should not serve as a barrier to students learning scientific content or any content. Teachers and other participatory stakeholders are responsible for creating equitable learning spaces and need support to create equitable learning

spaces. Teachers need to be engaged in equity focus PDPs that model how to effectively integrate their students' cultural and lived experiences in not just their physical classroom learning environment but also in their pedagogical decisions. Teachers participating in PDPs will also help teachers like Jordan see that building relationships and creating safe spaces for students is not a female teacher attribute and a critical factor in creating an equitable learning environment.

Without sincere efforts to support teachers in developing equitable learning spaces, there will continue to be classrooms where students are forced to engage in inequities in the way they receive instruction based on teachers' seeing their cultural assets as deficits. Some teachers will continue to teach students from diverse cultural backgrounds from a deficit without seeing their differences as characteristics to welcome and celebrate in the classroom. The inequities in these classrooms will then produce students who see science as a class they have to take and not as part of their daily lives or a career path they can participate in. Teachers, administrators, and other educational stakeholders need to come together to dialogue about equity and work as a collective toward creating equitable spaces for all students, especially diverse learners.

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APPENDICE

Appendix A

Interview Protocol and Focus Group Question prompts for Teachers

These interviews will take place either in person or on a virtual meeting platform.

Interview 1: Background and Teacher Initial Thoughts on Equity

1. What is your name?
2. Take me back to your teaching preparation program. First where did you receive your initial teacher preparation?
3. Was equity ever discussed during your teacher preparation program?
4. While in your teaching career have you had any significant experiences where your learned about creating equitable learning spaces in science classrooms?
5. Describe equity in your own words.
6. Do you think equity is important to an educational learning environment or experience?
7. Describe what creating an equitable learning space means to you?

Interview 2/ Conclusion Interview

Observation questions will not be finalized until after analysis of initial interview and focus groups.

1. What are some take a ways you received from participating in this study?
2. Describe any challenges you encountered as you think of ways to create equitable learning spaces and experiences in your classroom?
3. What do you think are some of your own barriers to creating content that can connect with the diverse backgrounds of your students?

4. What are your further implications in your pedagogical practice with the information you have discussed or gained from the focus groups with other teacher participants?

Focus Group 1

Now that you have had some time to read and reflect on the Closing the Gap: Creating equity in the classroom handout, Diversity and equity in science education, and the assessing equity article, I will now ask you some questions about information found on the various reading Materials . Teachers will also be asked to look at their current week's lesson plans to reflect on how they made the material assessable to all students.

1. In what ways have you in the past or currently assess your own culture as well as classroom culture and how it may or may not affect your students?
2. In what ways do you feel equipped to create an equitable learning classroom environment teaching science?
3. In what ways do you think culture influences how a student finds a sense of place in your classroom?
4. In what ways do you feel that creating equitable learning environments are necessary or beneficial for English Language students or other diverse learners in a science classroom?
5. Describe what an equitable learning space means to you.
6. In what ways do you feel supported by district and school administration to provide equitable learning spaces in your classroom learning environment?

Focus Group 2

Teacher participants are asked to bring artifacts with them to the second focus group that show how they have created equitable learning spaces and experiences within their science classroom. This focus group will be in a show and tell arrangement. Teachers are asked to bring artifacts that represent both academic content and classroom learning environments examples of how equitable learning spaces and experiences have been created by the teacher participants. Teachers will be prompted to answer the questions listed below about their artifacts.

Academic Artifacts

1. How does your artifact exhibit equity?
2. Is your artifact science specific ?
3. What is something that you enjoyed about this activity?
4. What is an element that you think your students enjoyed about this activity?

Classroom Learning Environment Artifacts

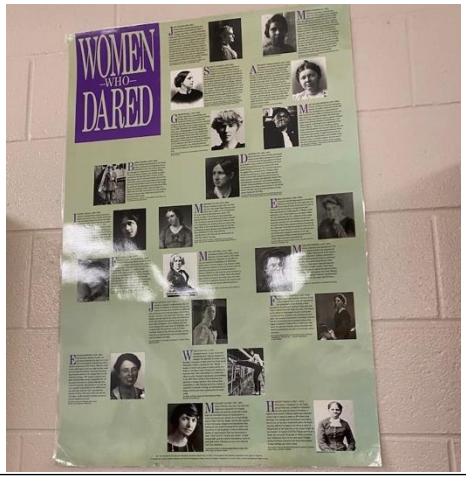
1. How does your artifact exhibit equity?
2. What is something you enjoy about this element of your classroom learning environment?
3. How do you think this element in your classroom learning environment is beneficial for students?

Appendix B

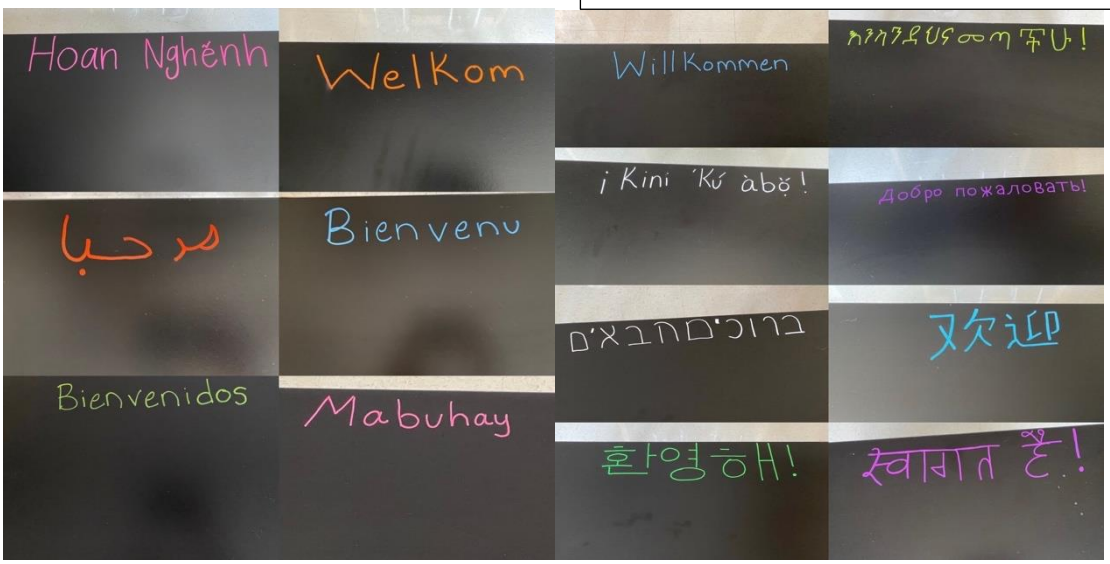
Artifacts from Participants

Black Lives Matter sign in Grace's classroom

Picture of Welcome Message on windows in Grace's classroom.



Poster of women scientists in Grace's classroom



Picture of welcome messages on student desks in Grace's classroom

Picture of Evelyn's Scientist Representation Wall in her classroom

Name:_____ Class:_____ Date:_____

Circular Motion and Univ. Grav. Test

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. **A tin can whirled** (hacer girar) **on the end of a string** (cuerda) **moves in a circle because:**

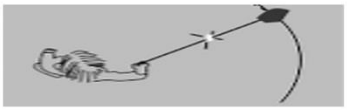
a. Once the can starts moving, that is what it does **naturally** (instintivamente).

b. Gravity acts on the can.

c. There is a **force** (la fuerza) on the can pulling it **away from** (lejos de) **the center** (el centro).

d. There is **a force** (la fuerza) **acting toward** (hacia) **the center** (el centro) of the can.

2. **If you whirl** (hacer girar) **a tin can on the end of a string and the string suddenly breaks** (romper), **the can will**



a. **fly** (volar) directly **away from** (lejos de) you.

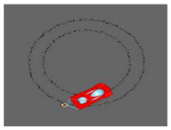
b. fly directly **toward** (hacia) you.

c. fly off, **tangent to** (tangenta a) its circular path (el camino).

d. **spiral** (la espiral) away from (lejos de) your hand.

Example of how Jordan's physics curriculum group adapted their tests for Spanish speaking English language learners

3. **A car travels in a circle with constant speed. The net force on the car:**



a. is directed **forward** (adelante), in the direction of travel.

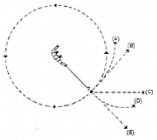
b. is directed **toward** (hacia) the **center** (el centro) of the curve.

c. is zero because the car is not accelerating.

d. **None** (ninguna) of these answers is correct.

4. **A steel ball is attached to a string and is swung in a circular path as illustrated in the figure below. At the point P, the string suddenly breaks** (romper). **Which path** (el camino) **would the ball most closely follow after the string breaks.**

a. A
b. B
c. C
d. D
e. E



5. **In what direction** (la direccion) **does centripetal force point** (apuntar)?

a. **Toward** (hacia) the center

b. **Outwards** (hacia fuera)

c. **Tangent to** (tangenta a) the circle

d. **Nowhere** (en ninguna parte)

Name:_____ Class:_____ Date:_____

6. **In what direction** (la direccion) **does centripetal acceleration point** (apuntar)?

b. **Toward** (hacia) the center

c. **Outwards** (hacia fuera)

d. **Tangent to** (tangenta a) the circle

e. **Nowhere** (en ninguna parte)

7. **What does centripetal force depend on** (depender)?

a. Mass

b. Velocity

c. Radius of the circle

d. All of these answers are correct.

8. **What would happen to the gravitational force (F) felt between two objects if the radius between them were doubled?**

X 2

a. **F** would double

b. **F** would cut in half

c. **F** would divide by four

d. **F** would stay the same

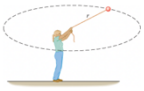
9. **What provides the centripetal force for a ball on a string being twirled in a circle?**

a. Friction force

b. Inertia

c. Tension force

d. Air resistance



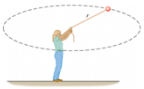
10. **If you spin a rock on a string over your head and the string suddenly breaks** (romper), **the rock will:**

a. **Fly** (volar) directly **toward** (hacia) you.

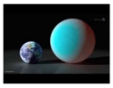
b. Fly off in a **straight line** (linea recta), tangent to the curve.

c. **Spiral** (espiral) **away from** (lejos de) your hand.

d. **Spiral** (espiral) **toward** (hacia) your hand.



11. **What would happen to the gravitational force (F) felt between two planets if the mass of one planet were doubled?**



a. **F** would double

b. **F** would cut in half

c. **F** would divide by four

d. **F** would stay the same

12. **As a car goes around a left turn, the passenger** (pasajero) **feels squished** (aplastado) **toward the door of the car. What causes his body to feel this?**

a. Newton's First Law of Inertia, making his body want to continue **straight** (derecho)

b. Gravity pulling him down to the **seat** (asiento)

c. Centrifugal Force pushing him out the door

d. Friction of his **bum** (extreme) on the **seat** (asiento)