CREANDO MAESTROS CIENTÍFICOS:

PREPARING PRE-SERVICE TEACHERS TO TEACH EMERGENT BI/MULTILINGUAL STUDENTS SCIENCE

by

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HONORS THESIS

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ABSTRACT

Bilingual education takes many forms, but all forms are created to address the educational needs of emergent bi/multilingual students. These are students of all backgrounds, races, and ethnicities who are learning a new language in addition to academic content. Current research suggests that teachers take a culturally relevant approach to teaching their students. Gloria Ladson-Billings described three steps towards developing culturally relevant pedagogy as "supporting students in maintaining their community and heritage ways with language and other cultural practices in the process of gaining access to the dominant ones" (Paris, 2012, p. 94). While there are many suggestions for how to provide culturally relevant instruction in the classroom, the question arises: How do we best prepare pre-service teachers in Bilingual Bicultural education programs to address the needs of their future emergent bi/multilingual students in science content areas? In this paper, I discuss previous research on culturally relevant practices within the science classroom and provide examples from the field. Based on the science teacher-education sequence at Texas State University, I then offer concrete examples of how to augment or enrich current courses and better prepare our future teachers for their future culturally and linguistically diverse classrooms.

Creando Maestros Científicos:

Preparing Pre-Service Teachers to Teach Emergent Bi/Multilingual Students Science

Introduction

The role of a bilingual teacher is one of the most in demand job positions in the education field (Leake, 2018). Following an increase in the number of emergent or already fluent bi/multilingual students in recent years, the demand for bilingual teachers who can address the needs of the students is also increasing. In 2018 "1 out of every 4 students in the U.S. speaks a language other than English at home" (García & Kleifgen, 2018, p. 11). Additionally, "approximately three-fourths of all emergent bilinguals in the United States speak Spanish as their home language" (García & Kleifgen, 2018, p. 35). As such, it is important that bilingual teachers in Texas are prepared with as many evidence-based teaching-strategies as possible to experience success and learn to provide the most effective education for emergent bi/multilingual students.

With increasing diversity of culture, race, ethnicity, and languages in our classrooms, teachers and researchers are still looking for the best way to teach emergent bi/multilinguals in a way that recognizes and utilizes their prior knowledge and skills and counters deficit perspectives. Current research encourages the use of culturally relevant teaching practices to assure the success of historically marginalized students. Gloria Ladson-Billings (Cox-Petersen, Melber, & Patchen, 2012, p. 4) defined three main aspects of culturally relevant teaching:

- **Assisting all students** to achieve academic success

- **Focusing on cultural competence** to help students maintain their own cultural integrity through classroom activities
- **Ensuring critical consciousness** through activities that address cultural norms, values, and social inequities.

While there are many suggestions of culturally relevant strategies current teachers may implement in their classrooms across all content areas, the instruction of pre-service teachers is not widely discussed, especially in regards to science.

In this paper, I will use a culturally relevant practices framework to explore guidelines for preparing pre-service teachers to teach emergent bi/multilingual students in the content area of science. First, I will discuss culturally relevant practices suggested in current literature and their benefits for emergent bi/multilingual students. Then, I will describe the science preparation of pre-service teachers in the Bilingual Bicultural Education track at Texas State University. Finally, I will provide suggestions for improving the preparation of these future teachers in the content area.

Rationale

As a pre-service teacher in the Bilingual Bicultural track of the College of Education at Texas State University, this topic is especially important to me. I classify myself as a simultaneous bilingual, as I learned both English and Swedish at the same time and can't choose one over the other when asked what my "first language" is. I decided to become a teacher after participating in the Instructional Practices in Education and Training course at my high school. I loved the experiences I had working with

students in pre-K, 2nd, and 3rd grade in Plano ISD, and even had the opportunity to speak to some of those students in Spanish. I took Spanish classes from 7th through 12th grade because I loved the language and wanted to build on my fluency in my third language. When I realized Texas State University requires the selection of either the Bilingual Bicultural or the ESL track for the Early Childhood-6th grade certification area, I chose the Bilingual Bicultural track. I saw how I, by teaching in the Spanish language, would be able to retain what I had learned in addition to providing the quality education my future students will need.

Inspired by the classes I have taken so far, I started to re-write my notes for General Science in Spanish two summers ago. After translating about a semester's worth of content, I asked myself the following question: *Why have I not taken any science classes in Spanish?* I found myself cross-referencing different English-Spanish dictionaries trying to find the correct words for the difference between "erosion" and "weathering," and contemplating how useful it would have been to be formally educated in the academic language of science in Spanish. Furthermore, I found it was odd that I was putting in extra effort during my summer vacation to familiarize myself with the specialized vocabulary science consists of in order to better be able to teach the subject in the language my students understand.

Now, after going through the Bilingual Bicultural Blocks at Texas State, I have learned more about language acquisition and the deficit perspectives facing the Latinx student population. Paris (2012) described these deficit perspectives as viewing the languages, literacy practices, and cultural ways of being of students of color as "deficiencies to overcome in learning the demanded and legitimized dominant language,

literacy and cultural ways of schooling" (p. 93). Throughout this paper, the term bi/multilingual refers to all students who are learning a new language in addition to academic content. Following the thoughts of Martínez (2018), I concur that the terms most commonly used to label these students, English Language Learners (ELLs), English Learners (ELs), or students who have Limited English Proficiency (LEPs), emphasize a deficit perspective about what these students bring to the classroom and neglect to recognize the full linguistic repertoires from which they currently operate. The term emergent bi/multilingual, however, recognizes that students may be working on developing their second, third, fourth language, etc. and validates their previous language experiences.

After the implementation of No Child Left Behind (NCLB) and its more recent adaptation, Every Student Succeeds Act (ESSA) (US Department of Education, 2021), there is more of a push to ensure students have the English proficiency levels they need to pass standardized tests (Genishi & Dyson, 2009). In order to do so, states are required to "develop English language proficiency standards for emergent bilinguals, as well as an assessment instrument aligned to these standards that measure listening, speaking, reading, writing, and comprehension" (García & Kleifgen, 2018, p. 14). In fact, "many elementary school learners in Texas [and other states across the country] receive instruction aimed at English monolingualism rather than biliteracy or the development of academic skills in two languages" (Murillo, 2012, p. 19). This is due to the fact that "it is assumed that proficiency in English is a prerequisite for learning subject matter" (Stoddart, et. al., 2002, p. 665). However, academic language proficiency levels in a new language take an average 5 to 7 years to fully develop, which exceeds the time many

emergent bi/multilingual students have access to first-language resources in transitional bilingual education (1-3 years) or ESL programs ("as needed") supported by NCLB or ESSA (Crawford & Krashen, 2015, p. 28). Both such programs have the goal of encouraging students to learn English as fast as possible, taking the social language proficiency developed after 2-3 years as the indicator for their future success in English-only classes (Crawford & Krashen, 2015, p. 27). All of this only contributes to the deficit perspective on these marginalized populations who are viewed as "English deficient."

This leads me to consider my own Spanish language proficiency as a future bi/multilingual teacher. I continue to ponder feeling like I do not know enough Spanish to effectively teach in science. The idea of teaching emergent bi/multilingual students a content area that is so niche in a language I may not be academically fluent in is quite honestly very intimidating. I have surmised many of my fellow Bilingual Bicultural classmates feel the same. With these wonderings in mind, I formulated my research question: ***How can we best prepare pre-service teachers to teach emergent bi/multilingual students science concepts?***

Texas State University (2021), originally Southwest Texas Normal School, has been dedicated to educating educators since its doors opened in 1903. The College of Education website (2021) not only promotes Texas State as having the #1 teacher education program in Texas and #2 in the entire United States, but also as the largest university-based teacher education program in Texas with a total of 904 candidates completing the program in the 2012-2013 academic school year. In 2021, the teacher education program offered 32 different certification areas, including bilingual education, special education, and all-level programs. Additionally, Texas State (2021) was

designated a Hispanic-Serving Institution in 2011 by the U.S. Department of Education, uniquely positioning the university to be a leader in what it means to educate ESL/Bilingual teachers who fit the demographic and/or will be educating Hispanic students. As such, it is important that pre-service teachers, both in the Bilingual Bicultural and the ESL Generalist programs, are provided with a holistic look into teaching all subjects in culturally relevant ways to enhance student understanding and engagement. Currently, emphasis in both the Texas State Bilingual Bicultural Education program and current research are focused on reading and writing. There appears to be a need to expand the focus to also include the subjects of math, social studies, and science.

Literary Review and Theory

I now present a brief review of research about culturally relevant teaching practices that can be used in the science classroom to aid and augment the learning of emergent bi/multilingual students. Then, I follow with a description of Inquiry-Based Instruction in order to demonstrate how it facilitates the implementation of culturally relevant teaching. Finally, I summarize statistics on how current teachers feel about their preparation and the resources available to them for teaching science content.

Culturally Relevant Practices in the Elementary Science Classroom

Culturally relevant teaching, as defined by Ladson-Billings (1995, p. 483), "must reach three criteria: an ability to develop students academically, a willingness to nurture

and support cultural competence, and the development of sociopolitical or critical consciousness." Specifically, educators must address student achievement, "help[ing] students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate" (Ladson-Billings, 1995, p. 469). This type of teaching is especially vital to the education of marginalized populations, such as emergent bi/multilingual students, as it counters the deficit perspectives imposed by white, monolingual-English norms.

One of the most significant examples of culturally relevant practices is the use of home language or first-language instruction. By using the language that the students are most familiar with for instruction, teachers are better able to assess what the child already knows about a topic and build their lessons off that knowledge. First-language or home language instruction also recognizes that learning a new language on top of new concepts can be difficult and stressful for children. Teachers may incorporate a translanguaging lens on language acquisition into their classrooms and instruction. García (2020) explained how bi/multilingual people have a unitary linguistic repertoire, not separate repertoires for each language. Because of this, translanguaging refers to the fact that bi/multilingual students are able to utilize features from their multiple languages in order to make sense of the world around them, meet conversational or academic needs, and learn new, challenging content (CUNY-NYSIEB, 2014). In other words, a translanguaging lens does not view a bi/multilingual student as having a Spanish brain and separate English brain but instead views the language practices through which bi/multilingual students engage all their languages. Students are then able to bring their whole selves into their learning, as they are able to access the knowledge they have in

each language (García, 2020). Teaching in a language other than English does not mean the children will not learn their target language and be able to use it! In fact, "encouraging language development in the students' first language actually strengthens their acquisition of oral and written English" (Garan, 2007, p.133). The home language helps children make connections to scientific concepts (Riojas-Cortez, et. al., 2008). Through the process of language transfer, students are able to use the language they comprehend to make sense of a topic, then use the knowledge they have already developed to aid in the learning of relevant vocabulary (Crawford & Krashen, 2015). They will not need to relearn the concept in English, just the words in the new language that help them communicate their ideas. This part of the process can be aided by looking at the differences between the languages of the student – the home language and the target language – to compare science terms. Additionally, teachers may consider putting emphasis on cognates. The Cambridge Dictionary defines cognates as words that "have the same origin, or are related and in some way similar" (2021). "While many science terms come from Latin and therefore have Spanish cognates," Spanish-dominant students may be unfamiliar with the terminology without direct science instruction in Spanish due to the fact it is not used in day-to-day conversations (Román, Briceño, & Basaraba, 2018). By reviewing cognates [see Table 1 for examples], teachers can provide bi/multilingual students with a strategy for comprehending and learning new vocabulary.

Table 1

Examples of Spanish and English Science Vocabulary Cognates[1]

Spanish Word	English Word
Biología	Biology
Atmósfera	Atmosphere
Investigar	Investigate
Consumidores	Consumers
Ecosistema	Ecosystem
Microscopios	Microscopes
Herencia	Inheritance

All students, no matter what background experiences they have, come to school with knowledge of the world around them. Riojas-Cortez, et al. (2008) describe the knowledge socially constructed in households and communities that children bring with them to the educational setting as "funds of knowledge". This knowledge can take diverse forms, including job skills, household management skills, religious knowledge, and more (Moll, et al, 1992). Because they have previous experience with different topics, it is imperative that teachers tap into the funds of knowledge of their students, their families, and community members in order to provide culturally relevant education. Incorporating these knowledge bases into the classroom allows children to connect to their own experiences in order to make sense of new information. Children from cultural and linguistically diverse backgrounds bring a science knowledge base that can enrich the science curriculum and help them make connections to the science content standards (Riojas-Cortez, et. al., 2008).

The use of cultural tools is another great way to incorporate culturally relevant practices in the classroom. "Science is often 'another world' for ethnically diverse

[1] Cognate examples were found at (The Science Toolkit, 2015)

students because science instruction and assessment do not relate to their lived experiences" (Cox-Peterson & Spencer, 2006, p. 21). By connecting to cultural tools in the classroom, teachers provide students with familiar activities they have experience with in order to introduce science concepts. Cultural tools include activities done in the home and the community such as gardening, cooking, storytelling, religious traditions, and more. Incorporating cultural tools into the classroom facilitates children in making connections to science concepts that may otherwise be too abstract (Riojas-Cortez, et. al., 2008). Additionally, because they are familiar with the activities that are being presented, students are more likely to engage in the learning and share their prior knowledge.

Some examples of culturally relevant practices in action can be found in publications like *A People's Curriculum for the Earth*. In "Lessons from a Garden Spider," a student finds a spider in the school yard, which he brings into the classroom. From there, the class spends weeks studying the spider, which they named Charlotte like the spider in the book *Charlotte's Web*, as well as the science competencies that correlate (Lyman, 2014). The teacher expresses their concern for their students, saying "I felt overwhelmed by the challenge of meeting the standard and bringing my students' test scores up while at the same time making school meaningful and inspiring them to learn" (Lyman, 2014, p. 49) By beginning the project with a topic that her students picked, the spider, the teacher was able to engage students in asking questions about the spider, as well as connect the spider's activities to concepts such as her life cycle, food chains/food webs, and taking care of creatures in the environment that would not have hit home the same way using the district's mandated, out-of-context curriculum. Emergent bi/multilingual students were not only able to engage in conversations about a creature

they were able to observe in real time, but also contributed in writing a section of the class newsletter in their home language (Lyman, 2014). Another example, "Polar Bears on Mission Street," shows emergent bi/multilingual students connecting to the concept of global warming through activism. The students read an article about the melting of the polar ice caps, then began asking questions about how they could help save the polar bears. After learning about different things that contributed to global warming, students were able to connect to their lived experiences. The teacher describes, "because we live in an urban community, it was easy for my students to see how too many cars on the road create air pollution, and understand the benefits of public transportation" (Cloues, 2014, p. 159) They also explored the concept of greenhouse gases using a model of the Earth and its atmosphere to solidify their understanding of an otherwise foreign, abstract concept. Then, as part of a community service project event for César Chávez Day, the students created bilingual posters describing small steps to take that would reduce the impact of global warming, as well as asking for donations to the National Resources Defense Council's "Polar Bear SOS" campaign. One student even walked down the street talking to people he met about the issue, using his full linguistic repertoire to explain the melting of the polar ice caps and asking for donations in either English or Spanish (Cloues, 2014). Activities such as these, and many more described in literature, provide great examples of how current teachers may incorporate student's linguistic repertoires, prior knowledge, and cultural tools in their teaching using culturally relevant pedagogies.

Towards a Theory of Culturally Sustaining Science Teaching and Learning

Inquiry-Based Instruction provides many opportunities for emergent bi/multilinguals to incorporate their language and their funds of knowledge into their learning. "Science inquiry lessons allow students to explore, question, and build their understanding of natural phenomena as active learners while the teacher facilitates student learning" (Huerta & Spies, 2016, p. 24). This type of instruction encourages students to find a topic that interests them, formulate questions about that topic using science terms and that can be solved using science procedures taught during classroom instruction, as well as the use of academic language to share and discuss their findings. Because students are involved in the process of creating their investigation, students are encouraged to take more responsibility for their learning, which will contribute to increased engagement in classroom activities. Additionally, each step of inquiry-based learning assists the emergent bi/multilingual student with language learning and content learning. Table 2 describes the process skills students learn through inquiry, as well how language can be developed with each skill. Teachers can use this table as a resource, for example, to demonstrate the usefulness of inquiry and creating investigations in language acquisition to administrators and parents, as well as to guide the inquiry process. With all of these uses in mind, "science gives [emergent bi/multilingual students] a purpose to learn [another language]" (Huerta & Jackson, 2010, p. 207).

Table 2

The Importance of Inquiry-Based Process Skills

Process Skills for Inquiry-Based Learning [2]	Description of Process Skill	Importance for Language Development
Observations	Looking at the world you and taking note of things that interest you.	Students are encouraged to use academic language and vocabulary to note things they observe.
Posing Questions	Asking relevant questions about the topic that will lead to an answer found through investigation.	Students practice using question starters and structures.
Examining Information Sources	Doing prior research – building up background knowledge on the topic.	Students work on reading comprehension and meaning-making in the language(s) of the sources.
Investigation Planning	Designing the process of the investigation and the steps you will take. How will you find your answer?	Students can practice communicate with partners using academic language and vocabulary in conversation as well as in writing.
Making Predictions	What do you think the outcome of the investigation will be? What is your hypothesis?	Students can practice communicate with partners using academic language and vocabulary in conversation as well as in writing.
Proposing Explanations	Why do you think the answer ended up being that way? Reflecting on prior knowledge and the results of the investigation to suggest a conclusion.	Students can practice communicate with partners using academic language and vocabulary in conversation as well as in writing.
Communicating Final Results	Being able to present the findings of the investigation to an audience.	Students can practice communicate with partners using academic language and vocabulary in conversation as well as in writing.

Inquiry-Based Instruction is a powerful way to implement culturally relevant

[2] The process skills as defined in (Cox-Petersen, Melber, & Patchen, 2012, p. 19)

pedagogy into the science classroom. Because the teaching method is student-focused, where the students are the ones coming up with questions and designing investigations about things that interest them, emergent bi/multilingual students are able to connect to their funds of knowledge, cultures, and experiences in order to shape their learning. Inquiry also has the potential to lead to activism, as students uncover problems that need to be addressed in their communities through the inquiry process. Another example from *A People's Curriculum for the Earth*, "A Pedagogy for Ecology" describes how students should be encouraged to get to know where they live in order to better connect to and learn from the Earth (Pelo, 2014). After describing different investigations that were sparked from class walks through the community, the teacher discusses the story of how a class and their families worked together to save a tree in the school playground from being cut down. The class worked on writing letters to the local government with information they had learned about caring for trees and arguments for why it should not be removed (Pelo, 2014). This type of activism ties into the third, often missed, aspect of culturally relevant education described by Ladson-Billings: "Ensuring critical consciousness through activities that address cultural norms, values, and social inequities" (Cox-Petersen, Melber, & Patchen, 2012, p. 4).

Preparing Teachers to Teach Science

An article from Berkley Research in California described that one-third of elementary school teachers in the state felt that they are prepared to teach science (Hall, 2011). The impact of 66% of elementary teachers not feeling prepared to teach science

cannot be understated. When asked how prepared they felt to teach emergent bi/multilingual students, a mere 31% of elementary teachers felt they were ready (Dorph, et al., 2011). Additionally, 85% of the teachers stated that they "have not received any professional development in science during the past three years" (Hall, 2011) despite California's claim that science education is important for children. These statements from current teachers add to the concern – Why do these teachers not feel prepared? Why are they not getting the professional development they need to feel better prepared? How can we help these teachers, especially those teaching emergent bi/multilingual students, during their college preparation courses to gain the skills and confidence they need to teach science content?

The article gives some suggestions for how to combat the un-preparedness that the teachers of bi/multilingual students face when asked to teach science. "Curriculum that engages students in the investigation and doing of science, time for teaching, and well-prepared teachers with access to support and resources" are cited as topics that need to be addressed in the schools (Hall, 2011). As mentioned before, inquiry and investigations are an important part of culturally relevant education and are among the suggestions for the instruction of emergent bi/multilingual students. Time to teach, however, is a problem in and of itself. In 2012, Rolf K. Bank published findings describing the decline of instructional time devoted to science in schools, noting that it had been reduced to only 2.3 hours a week whereas instructional time for language arts and math took higher precedence (Blank, 2012). If teachers are encouraged to focus more on these content areas, how can we build their confidence to include science instruction into the classroom?

The culturally relevant strategies listed in this section, alongside Inquiry-Based instruction, are only the tip of the iceberg when it comes to teaching science for emergent bi/multilingual students. Knowing this, we need to take a deeper look into why teachers are not feeling prepared to teach science in their culturally and linguistically diverse classrooms starting with teacher preparation programs. In the next section, I will examine the science courses required of ESL Generalist and Bilingual Bicultural teachers at Texas State University.

Pre-Service Teacher Science Education at Texas State University

According to the 2020 degree plan outline, students in the Bilingual Bicultural program of the College of Education at Texas State University are required to take the following science courses to fulfill graduation requirements, which accounts to 21 hours in a 124 total hour degree plan:

- PHYS 1310 + PHYS 1320: *Elementary Physics 1 & 2* (6 credit hours) **or**
- PHYS 1360 + PHYS 1370: *Development of Concepts in Physics* (6 credit hours)
- BIO 1320: *Modern Biology* (3 credit hours)
- GS 3310 + GS 3320: *General Science 1 & 2* (6 credit hours)
- CI 4355: *Science in Elementary Education* (3 credit hours)
- CI 4362: *Elementary Bilingual Content Areas* (3 credit hours)

The first 7 courses are taught completely in English, and often depending on who the course instructor of any given course is, there is limited expansion on teaching emergent bi/multilingual students, no Spanish language usage, and limited discussion of

the role of language on science learning. The physics and biology courses are content courses for non-science majors, meaning the professors are teaching pre-service teachers the general concepts of those subgroups of science, and there are a variety of students from other degree-plans that require the same courses. *Physics 2* and *Development of Concepts in Physics* begin giving pre-service teachers a bit more context into how students learn and teaching practices to use with them for the content covered. However, the physics and biology courses usually are courses pre-service teachers take before even being admitted into the College of Education. *General Science I and II* are two pre-blocks classes, or classes pre-service teachers take before all of their classroom management and teaching strategy courses. In General Science, students take the place of their future students in order to learn about ways to answer possible science questions students may have through content learning in a lecture portion and investigations in a lab portion. This science class includes more strategies for how to encourage student engagement and learning as well as preparation for teacher certification exams by discussing the Texas Essential Knowledge and Skills (TEKS) standards expectations for what students should master, TExES certification test competencies teachers must know, and specific activities teachers may utilize in the classroom.

In addition, teaching science is addressed in the courses *Elementary Bilingual Content Areas*, which is taught in Spanish and English, and *Science in Elementary Education*, which is usually taught in English. *Science in Elementary Education* is a theory class where pre-service teachers explore creating science lesson plans using various templates as well as participating in investigations, much like General Science lab. *Elementary Bilingual Content Areas*, a course specifically for Bilingual Bicultural

education, discusses the integration of bilingual strategies in math and social studies as well as science, dividing the semester into sections. *Elementary Bilingual Content Areas*, like many of the other Bilingual Bicultural blocks classes, emphasizes the use of culturally relevant literature for integrated content instruction.

Due to the specialized and complex nature of science and academic language, it is concerning that there are so few science classes for teachers taught in Spanish at the collegiate level at Texas State University. Pre-service teachers in the Bilingual Bicultural track are recommended to provide instruction in the home language of the student for better understanding, yet are not provided with the scientific vocabulary in their content classes to do so. If pre-service teachers do not receive direct instruction of science terms in Spanish, they most likely will not encounter the words in day-to-day conversations making it difficult to communicate science concepts. While we have learned in our Bilingual Bicultural courses to understand language acquisition from a translanguaging/language practices approach versus a strict language separation approach, there still remains a need to expose pre-service teachers to culturally relevant pedagogical practices. Translanguaging has taught us not to separate languages as emergent bi/multilinguals do not have allocated language brains, however this separation is exactly what is happening within teacher education programs. Understanding language acquisition and how to integrate it into content areas does not happen in just one class, and considering the amount of science classes required of us, it is all the more important we receive repeated opportunities to practice and utilize language within content.

Discussion

We can determine that there is not much literature or understanding on how to best prepare pre-service bilingual teachers to teach their emergent bi/multilingual students in the content area of science. The following section provides some suggestions for improving university-based teacher education programs.

First, we need to revisit the use of "culturally relevant" pedagogy in the classrooms. More often than not, teachers are able to address the first two goals outlined by Ladson-Billings – assisting all students to achieve academic success and focusing on cultural competence (Cox-Petersen, Melber, & Patchen, 2012) - but miss opportunities to incorporate activities that develop critical consciousness. These conversations are important for students to have and assist in moving teaching strategies away from simply recognizing the student's cultures and needs to allowing them a space to think critically about the world about them. The term "culturally sustaining practices" has been used to summarize the continual cultural maintenance and advocacy provided in this type of teaching, but there is little mention of it in current research despite reference by instructors in the field.

Culturally sustaining teaching should be incorporated into the science courses that pre-service teachers take at the university level, regardless of the final certification plan. This is because the pedagogy recognizes the inequities in our current education system placed on marginalized groups and combats deficit perspectives of their education. No matter what the teaching certification, we will inevitably encounter students from these populations in our classrooms. The term "culturally sustaining," as explained by Paris (2012), requires educators to look beyond simply being responsive or relevant to the

funds of knowledge, culture, lived experiences, and practices of emergent bi/multilingual students. Instead "it requires that they support young people in sustaining the cultural and linguistic competence of their communities while simultaneously offering access to dominant cultural competence" (Paris, 2012, p. 95). The term culturally sustaining is not commonly used throughout research for best practices for teaching emergent bi/multilingual students although including it would be beneficial for future pedagogical practices.

Second, while content courses such as Modern Biology and Physics for non-majors may allow a wide variety of majors in the courses, having a specific section of these courses for potential education majors that provide in-depth examples of how to incorporate what they have learned into teaching would be ideal. For example, when covering the topic of cells in *Modern Biology*, I was asked to read the book *The Immortal Life of Henrietta Lacks* by Rebecca Skloot. This book described the unjust use of a black woman's cancer cells for research and how the repercussions affected her family. The use of this book in the class provides an example of the critical consciousness aspect of culturally relevant education, as students reading it are asked to consider the impact such research practices have on the Black community. This type of activity should be emphasized to pre-service teachers to get them started on thinking about how literature can provide access to culturally relevant practices in different content areas. Another great example is the recently created Texas State *Development of Physics Concepts* course, first offered in Fall of 2019, which supplies opportunities for pre-service teachers to explore hands-on activities and student-oriented pedagogy while working with children (Texas State, 2019). Unfortunately, this course was likely not offered to most of the

current students in the Bilingual Bicultural Blocks who were expected to have completed this course and Modern Biology before applying to the College of Education.

Finally, culturally sustaining teaching could also be expanded in the *General Science I and II*, where the use of inquiry and investigations is exemplified amidst more science content, and in the *Science in Elementary Education* course. The latter course has the most potential for incorporating culturally sustaining practices as it is meant to prepare pre-service teachers in creating science lessons, and depending on the instructor, culturally relevant suggestions may or may not be covered in the course already.
In addition to culturally sustaining practices incorporated into their science courses, teachers in the bilingual track would benefit from taking at least one science instructional course in Spanish.

Elementary Bilingual Content Areas, the only course that incorporates language development into the content areas of science, math, and social studies, does not provide pre-service teachers with enough practice. As the class covers three content areas, language acquisition in the science classroom is reduced to about a month-long conversation. By implementing culturally relevant or sustaining practices into the science classes pre-service teachers are required to take for all certifications, future teachers will be better prepared to address the needs of their emergent bi/multilingual students.

Conclusion

Although there are many factors to be considered in the education of our future Bilingual Bicultural teachers, the ways we prepare them to teach science to their future

bi/multilingual students need to be reconsidered. When considering the increasing linguistic and cultural diversity of the education field, it is best to provide many opportunities for pre-service teachers to practice culturally relevant or sustaining pedagogy and understand language acquisition within the context of the science classes they are required to complete.

As for myself and my own preparation for teaching, I know there is still work I need to do in order to feel more comfortable teaching science to emergent bi/multilingual students. I will continue practicing my Spanish while working with children as a primary goal. My student teaching placement in Fall 2021 should, depending on my placement location, provide the opportunity to guide students through inquiry in Spanish and English as I gradually begin teaching each subject area. In order to teach in culturally sustaining ways, I will connect my lessons with literature that reflects the identity of the students and create a space where they are encouraged to ask questions and use their funds of knowledge to relate to the lessons using their full linguistic repertoires. I look forward to working side by side with my students in our language acquisition journeys as I continue to utilize Spanish, English, and Swedish and aspire to learn other languages in the future. I look forward to working in a school district that provides plentiful professional development courses on the topics of culturally sustaining teaching, anti-racist teaching, and science education with supportive administrators and principals to guide me.

I have offered here an idea of what it could look like to prepare our Texas State teachers, both in ESL generalist and Bilingual Bicultural tracks. I encourage conversations between teacher educators and science educators for a more seamless

transition and better understanding of the science language practices of emergent bi/multilingual students.

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