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"I Should Only Use One Language": A Case Study of Spanish-Speaking Emergent Bilingual Students' Translanguaging Experiences in a Middle School Science Classroom

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Abstract: Despite the linguistic diversity in the United States, English-only norms persist in educational settings, placing culturally and linguistically diverse students at a disadvantage. Translanguaging, as a linguistic application of culturally relevant practice, utilizes students' first and second languages to enhance understanding and communication. Guided by core questions and thorough qualitative analysis, this case study delves into middle school emergent bilingual students' engagement and experiences with translanguaging in the science classroom within a monolingual school setting. Findings indicate that translanguaging positively impacts students' comprehension and engagement in science learning, facilitating access to content and strengthening home–school connections. However, students' attitudes toward translanguaging are influenced by the lack of institutional support and societal language ideologies, leading to mixed opinions about its effectiveness and preferences. The study emphasizes the importance of listening to students' voices and advocating professional support to establish multilingual educational environments to maximize the advantages of translanguaging practices.

Keywords: content and language integration; multilingual students; translanguaging; language-rich practices; content area classroom; language ideology; and science education

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1. Introduction

English-only policies in schools have long been known to detrimentally affect culturally and linguistically diverse (CLD) students whose backgrounds diverge from white, middle-class, and English-speaking norms [1–3]. Many educational institutions are built on monoglossic language ideologies, considering monolingualism as the societal standard, which consequently offer limited support for CLD students [2,4,5]. To foster inclusivity and empower diverse learners, educational research and practice must encourage the integration of students' cultural resources into academic environments [6,7]. Teachers dedicated to such work effectively counter "the institutionalized ways people. . .perceive, understand, and make sense of contemporary U.S. immigration that justifies native (white) dominance, and reinforces hegemonic power" [8] (p. 380). Failure to address these issues can lead CLD students to feel marginalized or ashamed of their native languages and dialects within educational settings [9–11]. Such language policies further exacerbate existing inequities by disadvantaging diverse students who lack familiarity with mainstream language practices [4,12].

Over the past two decades, numerous pedagogical approaches have emerged to support diverse learners and multicultural educational objectives and culturally relevant pedagogy (CRP) stands out as one of the most prominent [13,14]. CRP aims to enhance

the academic performance of CLD students by connecting school learning with their home culture [13–15]. Various studies have illustrated how CRP fosters effective learning environments and fosters equality by rendering learning more comprehensible and relevant to the lives of CLD students [1,16,17].

One particularly valuable application of CRP in classrooms is translanguaging, which utilizes students' first and second languages to aid understanding and communication [18,19]. Translanguaging can be especially beneficial for CLD students who are acquiring English or emergent bilingual students who have recently immigrated and are just beginning to learn English [20]. It enables them to engage in school tasks that might otherwise be overly challenging if presented solely in their second language [15,18,21]. By tapping into students' full linguistic repertoire, translanguaging facilitates a deeper comprehension of subject matter content for emergent bilingual students [13,20,22,23]. Furthermore, it fosters effective communication and allows emergent bilingual students to concentrate on learning content [24–26].

Translanguaging practices, as supported by research [13], are particularly beneficial for aiding students in navigating the linguistic challenges inherent in science-based content. Such content often encompasses intricate grammatical features, technical terms, and patterns that pose difficulties for emerging bilingual students [27,28]. While the language of science can erect barriers for second-language learners, simplifying language or watering down content does not assist students; rather, it may inadvertently create additional obstacles [13,29].

Despite the extensive exploration of CLD students' linguistic and cultural needs [30–33], there remains a dearth of research on emergent bilingual students' experiences with translanguaging as a pedagogical practice in science classrooms. This study aims to address this gap by investigating the experiences of four middle school emergent bilingual students. These students' perceptions and experiences with translanguaging in a middle school science classroom offer valuable insights into the ways translanguaging can benefit emergent bilingual students. This study was guided by the following core questions:

1. How do the four emergent bilingual students engage in translanguaging practices in a middle school translanguaging science classroom within a monolingual school setting?
2. What are their experiences and perceptions regarding this practice?

2. Literature Review

2.1. Monoglossic Language Ideologies in U.S. Schools

Despite the United States being a multilingual country with no official language, English-only ideology has historically prevailed as the norm and monoglossic ideology characterizes the societal perception of monolingualism as the standard [4,6]. From a monoglossic perspective, languages are separate entities from one another and people tend to adopt additive or subtractive views of what it means to learn a new language [6,21,25,34]. For example, schools typically approach bilingualism from either an additive or subtractive standpoint [4,35].

An additive approach to bilingualism, sometimes referred to as "elite" bilingualism, is commonly adopted by members of affluent communities whose primary language is English [4]. It perceives bilingualism as a marker of intelligence, a valuable skill, and an educational strategy aimed at enhancing students' cognitive abilities [4,35]. Conversely, a subtractive view of bilingualism, often termed "minoritized" bilingualism, takes a deficit view towards individuals whose primary language is not English [4]. A subtractive approach means the students' bilingualism is often viewed as a problem because they are not English-proficient [4,35]. Often, the students come from less affluent communities, and they are encouraged to learn English at all costs, even at the expense of their first language [4,35]. English-only policies and monoglossic language ideologies reflect this deficit view [2,4,35].

Given that most schools exclusively use English as the language of instruction, monoglossic ideologies have significantly permeated educational practice [4]. Schools, which represent one of the most influential societal contexts for shaping learners' language

ideologies and practices, are particularly vulnerable to the dominance of English-only norms [5]. Numerous research studies highlight that bilingual students in such settings tend to shift their language preference from their native language to English to conform to the prevailing English-speaking norms [5,36,37]. This shift occurs because bilingual students in monolingual settings often encounter instances where their first language is marginalized, prompting them to adopt an English-only language ideology and preference [5,38].

2.2. Translanguaging

Given the significant influence of social contexts like school on students' language ideologies and beliefs [39], educational practices founded on heteroglossic language ideologies aimed at promoting multilingualism and linguistic diversity strongly advocate for bilingual students to cultivate all their languages [37,38]. Translanguaging emerges as a prominent pedagogical practice that reflects this ideology [34]. First described by Williams [40] and later extended by García [41], translanguaging involves bilingual students utilizing their full linguistic repertoire for learning, communication, and creative expression [21,34]. According to Espinosa et al. [23], bilingual students naturally engage in translanguaging practices in daily conversations and activities. Several scholars have illustrated how translanguaging serves as an additive educational approach by encouraging students to leverage their full linguistic knowledge and skills in school [23,26,42–44]. By focusing on the meaning-making process, translanguaging provides opportunities for students to utilize their linguistic knowledge as valuable resources [21,45–47].

As a result, translanguaging emerges as a powerful pedagogical tool for enhancing CLD students' language and literacy skills [19,44]. Students who engage in translanguaging can effectively communicate, expressing themselves more fully and accurately than if restricted to English-only practices [19,44,48]. Since translanguaging allows students to incorporate vocabulary and sentence structures from their first language, it can alleviate English language concerns for emergent bilingual students who are beginners of English language [19,24,48]. By relieving this cognitive burden, translanguaging enables English learning students to focus solely on content regardless of their English language proficiency [24,25]. Consequently, numerous research studies indicate that translanguaging enhances students' comprehension of subject matter and fosters positive attitudes toward academic learning [21,23,47].

Similarly, translanguaging provides advantages in students' comprehension through writing [44,49]. Writing serves as a tool to enhance student comprehension, with language playing a vital role [44,49,50]. For writing to be meaningful and supportive, students should be able to utilize their first language to access their full linguistic repertoire of meaning, ideas, and thinking [42,51]. Emergent bilingual students, when utilizing their languages and linguistic knowledge as resources, can derive the benefits of writing for learning content while enhancing their linguistic proficiency [23,42,52].

3. Methodology

This multiple-case study aimed to explore the experiences and perceptions of translanguaging practices among four emergent bilingual students in a monolingual school setting. A multiple-case study design is a qualitative research method that allows for an in-depth analysis of several cases [53]. This design allows for examining differences and similarities both within and across the four cases, providing a comprehensive understanding of the phenomena compared to what a single case study might have revealed [53]. The subsequent sections introduce the school environment where the participants were situated, delineating the context of the translanguaging science classroom where they collaborated with their teacher, Ms. Irene. Additionally, these sections outline the participant students, their teacher, the data sources utilized, and the analytical procedures employed in this study.

3.1. Context

This study was conducted as part of a collaborative initiative involving two higher-education institutions and a public school district in the northeast part of the United States. In partnership with Brown public school district (pseudonym), the two universities developed and implemented a longitudinal STEM program aimed at providing middle school students with transformative STEM experiences, particularly targeting underrepresented populations in STEM fields. The program utilized Lemelson-MIT (Massachusetts Institute of Technology)'s invention-based curriculum as the framework for STEM learning experiences. This curriculum comprised eight invention education guides, including "Junior Varsity (JV) InvenTeams activity guides" (https://lemelson.mit.edu/resources/curriculum-invention, accessed on 1 August 2018.), aligned with Next Generation Science Standards and tailored to educators and students in grades 6–10. Among these units, the research team adapted and modified the "Chill Out" unit to implement in a 7th grade science classroom for CLD students by integrating visualizations, culturally relevant "HomeFun" activities, and writing instructions aligned with 7th grade science standards. This revised curriculum was incorporated by six seventh-grade science teachers across two public middle schools within the same school district. This study specifically focused on one of these teachers' classrooms and examined the experiences of four CLD students during the 2019–2020 academic year.

Davis Middle School and Ms. Irene's Translanguaging Science Class

Davis Middle School (pseudonym) in the Brown public school district was the participating middle school this study and is in an economically mixed suburb in the northeastern part of the United States. Although the school district has a high number of students whose first language is not English, English is the only medium of instruction for the middle schools.

This study focuses on Ms. Irene's science class, which adopted translanguaging as a method of teaching science. Despite the absence of institutional support or the practice of translanguaging pedagogy within the school, Ms. Irene, propelled by her own multilingual background and empathy for her students, wholeheartedly adopted translanguaging practices despite not having been previously exposed to the concept. Ms. Irene fluently speaks Spanish and English and is both an English as a Second Language (ESL) and Science teacher at the participating middle school. With three years of ESL teaching experience and starting her first year teaching science, she was the only practitioner to adopt the translanguaging method in the entire school at the time of the study.

Ms. Irene's classroom was special and unique because the teacher spoke all her students' languages. This made it easier for her to adopt the translanguaging method and create an environment where everyone could translanguage and communicate naturally in both their first and second languages. The teacher used all the students' languages to explain scientific concepts in the classroom. For example, when she explained conduction, she first did so in English and then in Spanish. The translanguaging was so constant and natural that Ms. Irene sometimes did not notice which language she was speaking. Furthermore, monolingual students who only spoke English also picked up Spanish words throughout the lessons as they were constantly exposed to both English and Spanish.

Among her 18 students, 8 were Spanish-speaking English language learners, 16 were Spanish–English bilinguals, 2 were Portuguese–English bilinguals, and 2 were English-speaking monolinguals. Without language restrictions in her classroom, students freely utilized both their primary and secondary languages for communication. Ms. Irene employed students' languages for interactions, providing verbal and written instructions accordingly, and encouraged students to leverage their home languages for learning in any context. Students were given the flexibility to choose their preferred language(s) for assignments.

3.2. Content and Procedures

3.2.1. The Chill Out Curriculum

At the outset of the Chill Out program, students delved into concepts related to heat transfer, including convection, conduction, radiation, insulation, and thermal equilibrium. These concepts were introduced through whole-class lessons supplemented by a series of hands-on activities and experiments. Additionally, two explicit lessons on language and writing were incorporated to equip students with the skills necessary to draft a report on their lunchbox invention.

While learning about the heat transfer concepts, students were challenged to apply their knowledge and experiences in solving real-world problems. Starting with a bare shoebox as their starting point, students undertook a cognitively challenging project to create an effective lunchbox which would block heat transfer. Students collaborated in groups of three or four to design a lunchbox capable of minimizing heat transfer, leveraging the knowledge and experiences acquired throughout the program. Their primary objective was to prevent heat transfer by mitigating conduction, convection, and radiation to ensure the contents, a water bottle, remained cool. Insulating materials at their disposal included aluminum foil, bubble wrap, packing peanuts, old clothes, and construction paper. Throughout this process, they encountered and resolved various challenges while integrating scientific content into practical applications.

Following the completion of each group's invention, the effectiveness of their lunchbox was assessed through rigorous testing. Each group received a water bottle to place inside the lunchbox, which was then subjected to a heat lamp for approximately one hour. Subsequently, students utilized the test results to write their reports, presenting them as patent applications advocating for their lunchbox invention. Before commencing the report-writing process, the teacher provided language and writing support to guide students in composing reports tailored to captivate a public audience.

3.2.2. HomeFun Activities

The HomeFun activities were designed to bridge students' home experiences with the school curriculum [17]. Each student engaged in four HomeFun activities with family members (Table 1). These tasks aimed to connect students' understanding of heat transfer to their family's cultural and social knowledge, fostering culturally relevant learning links between home and school. HomeFun activities were presented in both students' primary language and English, and students were given the option to respond in either their primary or English.

Table 1. List of HomeFun activities.

1.	How we heat or cook things in my home country/town
2.	Famous inventions from my home country/town or elsewhere
3.	Clothing that keeps us warm or cool
4.	How we keep cool in my home country

3.3. Participants

This study focused on four seventh-grade emergent bilingual students from the middle school, Carter, Linsey, West, and Brian (pseudonyms). The selection criteria included the following: (1) recent immigrants to the United States, residing for less than a year, (2) beginners in English proficiency, scoring below Level 2 on the World-Class Instructional Design and Assessment (WIDA), and (3) full participants in the Chill Out curriculum who completed the lunchbox invention project and report writing in Ms. Irene's science class (Table 2).

Table 2. Student demographics.

	Carter	Linsey	West	Brian
Grade	7th	7th	7th	7th
Gender	male	female	male	male
Home Country	Guatemala	Guatemala	Guatemala	Guatemala
First Language	Spanish	Spanish	Spanish	Spanish
English Language Proficiency Level	WIDA Level 1	WIDA Level 1	WIDA Level 1	WIDA Level 1

Carter, Linsey, West, and Brian met these three criteria. Having arrived in the United States from Guatemala within the past year, Spanish was their primary language. Their English proficiency level was categorized as Level 1 according to the WIDA standards. Within the translanguaging classroom, Spanish was predominantly spoken among themselves and with Ms. Irene. They actively engaged in the Chill Out program and successfully completed the lunchbox invention and writing project.

3.4. Data Collection

The data for this study were comprised of classroom observations, student writing samples, and semi-structured interviews. I conducted observations in Ms. Irene's classroom during the Chill Out unit, documenting my observation through field notes. Semi-structured interviews with the four emergent bilingual participants provided deeper insights into their experiences with translanguaging. Additionally, the students' written documents, including HomeFun activities, report writing drafts, and class assignments, offered further understanding of their learning process.

3.4.1. Classroom Observations

I observed Ms. Irene's science classroom two to three times per week over a three-month period. Detailed field notes were taken on lessons, teaching materials, activities, and interactions to capture the students' experiences comprehensively. My observations focused on the students' learning progress, class participation, and their interactions with Ms. Irene and their peers. Informal conversations with Ms. Irene after each lesson aided in contextualizing my observations.

3.4.2. Semi-Structured Student Interviews

Semi-structured interviews were conducted with the students upon completion of the Chill Out program. Interviews took place in the school library during lunch hour, lasting 40–50 min each. For security reasons, the school did not allow unauthorized adults in the building; as a result, Ms. Irene facilitated translations of my conversations with each student. Interviews were audio-recorded and transcribed verbatim by a Spanish–English bilingual research assistant. To ensure accuracy, Spanish segments were re-translated by a private professional translator.

Interview questions were based on the research questions and designed to help student participants share about their experiences and perceptions related to translanguaging in science learning. Questions covered four major topics:

I. Perceptions toward translanguaging (e.g., "What is your opinion about translanguaging?" and "Which language(s) do you prefer to use in classes?")
II. Translanguaging experiences in school (e.g., "Do you use Spanish at school?" "If yes, when and how often do you use it?)
III. Translanguaging experience in the science classroom (e.g., "Could you describe your experience translanguaging in your science class?" and "How was your experience using both Spanish and English in the science classroom?")

IV. Writing experience in the translanguaging science classroom (e.g., "What language did you choose to write the final report?" and "Why did you choose to write in that language for your report?")

During interviews, I employed a form of member-checking by restating questions and students' responses to ensure I understood their meaning correctly and to enhance the validity of the research [54].

3.4.3. Student Writing Documentation

I analyzed texts and reports written by the four emergent bilingual participants, including initial and final drafts of report writing in class and HomeFun activities. These documents were translated into English by a professional translator before analysis. The documents were important in offering insight to participants' content knowledge development and language use during science instruction. Additionally, the design and experimental results and pictures of the lunchbox inventions offered helpful supplementary materials corresponding to the students' writing.

3.5. Data Analysis

As I began data analysis, I endeavored to develop a comprehensive understanding of the students' experiences by reading interview transcriptions, field notes, and student writing documents in their entirety. As I went, I took notes on my general impressions in the margins.

3.5.1. Analysis of Interview and Observation Data

An initial step in analysis involved uploading interview transcripts and field notes into ATLAS.ti, a qualitative data analysis software [55]. Utilizing qualitative thematic analysis techniques outlined by Braun and Clarke [56], I engaged in thematic analysis to uncover both explicit and implicit meanings through inductive analysis [57]. The first phase began prior to coding, where I familiarized myself with the data by listening to all voice-recorded interviews while reading the professionally translated transcripts. Despite my limited proficiency in Spanish, this step allowed me to grasp nuances in the participants' expressions and tones. I also reviewed field notes from classroom observations and became familiar with all collected data.

Subsequently, I generated initial codes aligned with the research questions, refining them through an iterative process of addition, combination, and splitting codes to speak across interview and observation data. These codes were then organized into thematic categories, ensuring alignment with the entire dataset. Refinement of themes occurred through meticulous review and comparison of transcripts and field notes while staying open to other emerging codes/themes as I worked. Visualization of themes using Atlas.ti aided in identifying broader patterns in the data. Additionally, I crafted succinct summaries for each theme to encapsulate their essence, followed by composing detailed explanations to present the findings.

3.5.2. Analysis of Students' Writing Documents

Students' writing was uploaded into Atlas.ti to facilitate qualitative deductive content analysis [58]. This approach, guided by a science literacy framework developed by Garcia [59] and expanded by Chiappetta and Fillman [60], allowed for the systematic exploration of the students' understanding of science concepts. Predetermined categories such as science as a body of knowledge, investigation, extending knowledge, and interacting with society served as lenses for analysis. I remained open to emergent ideas throughout this process. Excerpts from student writing were categorized based on predetermined criteria, with Word documents created for each category to document relevant excerpts. Ms. Irene's rubric scores for the students' writing were consulted to corroborate observations. Discussions with Ms. Irene further enriched the analysis and bolstered the validity of conclusions. Descriptive sentences were crafted for each category, with an independent

researcher verifying these findings against the Word documents. Representative excerpts from the students' writing were selected to support the explanation of findings.

4. Findings

The findings are divided into two main sections: (1) emergent bilingual students' understanding of science concepts and (2) emergent bilingual students' experiences and preferences regarding translanguaging.

1. *Emergent Bilingual Students' Understanding of Science Concepts*

As previously mentioned, the students successfully utilized two languages throughout the project to actively engage in the inventing process and writing the final reports. Initially, Carter, Linsey, and Brian drafted their reports in Spanish before translating the entire text into English using Google Translate. The translation was confirmed by Ms. Irene, who provided feedback on the students' writing throughout the process. In contrast to Carter, Linsey, and Brian, West employed translanguaging techniques between English and Spanish for his report writing. To assess the depth of their understanding of the science concepts taught in the curriculum, their writing was analyzed and compared. Although the depth of scientific knowledge regarding heat transfer varied among the participants, each final draft displayed some level of understanding of the heat transfer concepts.

Carter and Linsey's reports demonstrated a strong grasp of scientific knowledge, regarding the three primary heat transfer concepts taught during the project: conduction, convection, and radiation. Their reports demonstrated that they acquired knowledge about the three types of heat transfer concepts and their roles in the experiments. For example, Carter and Linsey wrote about conduction as follows:

> Carter: "Conduction is contact transfer. During the experiment, conduction occurs between the table and the bottle."
>
> Linsey: "Conduction is the transfer of thermal energy from one substance to another through direct contact. During the experiment, conduction occurs when we place the bottle on the table. To prevent being affected by heat transfer through conduction, humans have invented gloves because when they are put on, we don't burn."

Both Carter and Linsey's report demonstrated an understanding of conduction as the direct transmission of heat through a substance of varying temperature. Moreover, their explanations that conduction occurred between the table and the bottle indicated their comprehension of heat transmission through contact during the lunchbox experiment. Linsey's report further extended scientific knowledge to real-life examples, indicating her ability not only to apply the concept of conduction in an experimental setting but also to connect it with everyday situations.

Carter and Linsey also incorporated the scientific principles of convection and radiation into their reports, indicating their familiarity with these concepts through their lunchbox invention. For instance, Linsey's report illustrated that "convection is the transfer of thermal energy by the circulation or movement of a fluid (liquid or gas)". She further explained that convection occurred as gas moved through the air, demonstrating her understanding of convection as the transmission of heat based on its manifestation in the lunchbox experiment. Similarly, Carter effectively elucidated radiation. He described that "radiation is the transfer that produces deep electromagnetic covers", and then elaborated on where radiation occurred and how it was mitigated in the lunchbox experiment. He wrote, "radiation occurs when the lamp throws a lot of radiation, but the box materials such as aluminum reflect radiation. . . since [aluminum] is the one that reflects the radiation". Both Carter and Linsey's reports showcased their comprehension of the three types of heat transfer concepts and their roles in the experiments. They not only grasped the scientific principles but also applied them in the experiment and effectively articulated them in their writing afterward. This indicates a deeper understanding that transcended mere memorization of scientific facts.

On the other hand, Brian's report displayed only a partial understanding of the heat transfer concepts. Unlike Carter and Linsey's reports, his report fully explained one out of the three heat transfer concepts, radiation. For example, he described how radiation was observed in the lunchbox experiments, leaving out the explanation of the effects of conduction and convection. Similarly, an examination of West's report indicated that he acquired limited knowledge of the heat transfer concepts compared to the other students. Although his explanation encompassed all three concepts of heat transfer, his scientific comprehension seemed less advanced, with a notable absence of applied knowledge in the project compared to that of Linsey and Carter. West explained in writing that "heat transfer is hot to cold. Heat transfer in three ways, through conduction, radiation, and convection. Thermal equilibrium is when things have the one of the goals of this project is to prevent heat transfer by cold so it's not hot".

The analysis of writing by the four emergent bilingual students reveals that although the depth of scientific knowledge regarding heat transfer varied among the participants, each final draft displayed some level of engagement and understanding of the concepts learned in the class.

2. *Emergent Bilingual Students' Experiences and Preferences Regarding Translanguaging in Science*.

This following provides firsthand experiences of students as they engage with translanguaging across various activities, including HomeFun assignments, classroom lessons, and report-writing tasks. Additionally, it demonstrates the four emergent bilingual students' inclinations and preferences regarding the use of translanguaging specifically within the context of science classes.

a. HomeFun Activities: Fostering Connections Between Family and School Science

Students were offered the option to complete HomeFun activities in either Spanish or English, and all four students opted to do them in their first language, Spanish. In the case of the HomeFun activities, translanguaging occurred in a different context. In the science class, students used translanguaging by integrating both English and Spanish to enhance their understanding of scientific concepts. This bilingual approach allowed them to draw on their full linguistic repertoire. At home, while they completed activities in Spanish, the knowledge and concepts they engaged with were initially introduced through a translanguaging approach in class. Therefore, the HomeFun activities in Spanish are still an extension of the translanguaging process, as students are applying and reinforcing their bilingual understanding.

During their interviews, Carter, Linsey, West, and Brian highlighted how their family members actively contributed cultural insights and experiences to the HomeFun activities using their home language. The students expressed gratitude for their families' active participation in these activities, imparting that translanguaging positively influenced their family's engagement with science content. They shared instances of their families' involvement in their science homework.

Carter, who discussed his family's heating device used in Guatemala for his HomeFun activity, expressed his enjoyment of the tasks, emphasizing how they provided him with the chance to "saber más sobre las tradiciones de [su] familia" (*learn more about [his] family traditions*) from his parents. Likewise, West highlighted how his parents could contribute their experiences and knowledge to the HomeFun activities. When asked about his experience using Spanish for homework, he remarked,

> Bien, porque pregunté a mis papás si ellos sabían sobre esto. Entonces, ellos me explicaron un poco de qué es lo que se usaba en, de verdad, de lo que se usaba un poco en Guatemala.
>
> *(Good, because I asked my parents if they knew about this. So, they explained to me a little about how it was used in Guatemala, like for real, of what/how it was used in Guatemala sometimes.)*

With these words, West indicated that speaking in Spanish allowed his parents to be involved in his schoolwork and share their knowledge and experiences related to the topic. Linsey also conveyed her satisfaction in engaging with HomeFun activities in Spanish alongside her family, noting how it enriched her understanding of their home country. Brian further articulated how the translanguaging experience positively affected him, describing it as making him feel "bien [good]" due to the absence of language barriers in completing the assignments. When questioned about his experiences with HomeFun activities, Brian remarked,

> Lo siento muy bien, porque yo ya sé español, y puedo agregar palabras como que ya sé en inglés.
>
> *(I feel good because I already know Spanish, and I can just add the English words I knows).*

Brian's explanation indicates that translanguaging removed language barriers, allowing families to share their familial and cultural knowledge in school science-related tasks. By completing the assignments in their native language, students gained deeper insights into their culture and home traditions from their family members, an opportunity that may have been limited if the assignments were conducted solely in English.

In addition to gaining insights into their culture and traditions, these emergent bilingual students derived benefits from collaborating on science-related topics with their families. They received assistance from family members in understanding the functionality of their home-based heating or insulating devices. For instance, they learned about the mechanisms of their stoves, such as how they utilize gas as the primary energy source to generate heat, as explained by Carter: "La estufa absorve el gas y eso hace que haya fuego en la estufa" (the stove absorbs gas and that allows the stove to have fire). Similarly, Linsey elucidated how her stove "usa energía kinética" (uses kinetic energy) to transfer heat to objects. Both Carter and Linsey's descriptions indicate a robust understanding of scientific principles, bridging the gap between home and school-based content.

West and Brian also discussed the insulation of objects, such as lunchboxes, utilized by their families to maintain food warmth throughout the day. West elucidated that the lunchbox serves to "mantener toda la calefacción posible" (maintain as much heating as possible). He further explained that in his culture, it is utilized to inhibit heat transfer. Similarly, Brian identified the materials employed in the lunchbox to elucidate how lunchboxes prevent heat transfer, ensuring food remains warm throughout the day: "de cajas, aluminio, papel de burbujas, y nailo" (of boxes, aluminum, bubble wrap, and nylon).

These examples highlight the advantages students gained from using their primary language to discuss science content with family members, fostering robust cultural and family connections between these devices' utility in their families and cultures. Additionally, collaborating on HomeFun activities in their native language allowed students to collectively engage with science topics alongside their families.

b. Student experiences of translanguaging in science classroom

While the HomeFun activities showcased how translanguaging facilitated family engagement, its utilization in the classroom was also beneficial for these students. Despite not having fully developed proficiency in English, students were able to actively engage in the learning process and effectively complete their inventions and final reports through translanguaging. Utilizing two languages, students were able to comprehend science content and actively participate in both written and oral classroom tasks. All four participants emphasized that translanguaging enabled them to learn science on par with their English-speaking peers in the classroom.

I. Translanguaging in Speaking and Listening

When asked about the benefits of translanguaging in understanding science, Carter expressed that he comprehends scientific concepts more effectively when presented in both English and Spanish, compared to only in English.

> Aprendo mejor cuando me explican en español, así sé más los verbos, cómo los utilizan que en inglés.
>
> *(I learn better when they explain it to me in Spanish, that way I know the verbs more, how to use them, than in English).*
>
> He went on to say, Porque si, bueno, no puedo utilizar mucho en inglés. Entonces, si lo puedo entender un poco, pero no puedo explicarlo. Entonces, si me lo explica en mi idioma yo puedo entender más y mejorar más en estos aspectos.
>
> *(Because, if well, I can't use a lot of English. Then, I can understand it a bit but I can't explain it. So, if it is explained to me in my language, I can understand more and get better in these areas).*

In these statements, Carter highlighted the significance of translanguaging in enhancing his comprehension of science content, devoid of any barriers posed by his beginner level of English language proficiency.

Similarly, West underscored that he acquired a deeper understanding of science when presented in both in Spanish and English, emphasizing the importance of translanguaging for grasping science topics in class. He attributed his enhanced learning and greater content knowledge in the translanguaging class compared to non-translanguaging classes to his ability to comprehend the instructional materials. For instance, when asked about how translanguaging aided his learning, West responded without hesitation,

> Porque voy a entender más lo que se está aprendiendo en ciencias [en español]
>
> *(Because I am going to better understand what is being learned in science in Spanish).*

Similarly, both Lindsay and Brian expressed their belief that translanguaging facilitated their understanding of science because they grasp concepts better:

> Linsey: "Cuando el maestro se explica en inglés, no entiendo. Si lo explica en español ya entiendo." *(When the teacher explains in English, I don't understand. If they explain it in Spanish, then I understand).*
>
> Brian: "Cuando está hablando español, me ayuda a comprender por las explicaciones que me da y entiendo español." *(When you [Ms. Irene] are speaking Spanish, it helps me to understand the explanations that you [Ms. Irene] give me and I understand Spanish).*

Moreover, Brian mentioned that translanguaging assisted him in learning and comprehending science-related vocabulary that he was unfamiliar with in English. Collectively, these students' statements demonstrate that translanguaging empowered them to learn like any other student without encountering language barriers in the classroom. Without language restrictions, they were able to comprehend class lessons, and grasp science content. These benefits appeared to extend beyond oral communication to writing tasks as well.

II. Translanguaging in Writing

Carter, Brian, and West found translanguaging beneficial for their writing development in science. Writing in Spanish supported their understanding of the science content and increased their access to full participation in the writing activity. In a conversation between Ms. Irene and Carter regarding the writing activity in class, they had the following exchange:

> Ms. Irene: ¿Cómo entiendes mejor las cosas, cuando escribes en español o cuando escribes en inglés? *(How did you learn things better, when you write in Spanish or when you write in English?)*
>
> Carter: Español, entiendo mejor, bueno, because it is my language. Y se me facilitan las cosa. *(Spanish, I understand better, well*, because it is my language. *And it makes things easier for me.)*

Writing in Spanish supported Carter's understanding of the science content. In addition, Carter added that removing linguistic concerns in writing helped him to think about science content as he wrote, which helped his comprehension. He mentioned that,

> Porque, cuando voy escribiendo [en español], estoy pensando en cómo [sobre] son las ciencias.
>
> *(Because, as I am writing, I am thinking about how sciences are)*.

Free from linguistic concerns and distractions, Carter was able to concentrate solely on the scientific content and develop his thoughts as he wrote. This enabled Carter to enjoy the advantages of reflective and constructive writing processes. Similarly, Brian experienced a similar benefit and appreciated the flexibility of using either language when encountering unfamiliar words in English or Spanish:

> "Que las palabras que no sabía [escribir] como en inglés, las decía en español."
> (The words that I didn't know how to [write] in English, I would use Spanish).

By being able to write without language restrictions, Brian could fully engage in the writing process and direct his focus towards the content rather than the language itself. Likewise, West, who utilized translanguaging in his report writing, viewed it as a method to engage with writing:

> "Lo escribí un poco español y un poco inglés, porque yo intenté como mi método."
> (I wrote a little in Spanish and a little in English because I tried it as my method).

Overall, each participant reported positive experiences with translanguaging as they learned science, indicating that the removal of language restrictions provides significant benefits for emergent language learners in understanding science content.

c. Emergent Bilingual Students' Preferences of Using Translanguaging

Despite the apparent benefits of translanguaging in providing students access to content learning and fostering strong home/school connections, participants held mixed opinions about whether they considered translanguaging to be an effective approach for their learning. While Ms. Irene facilitated their access to content through her linguistic skills in Spanish, students still felt pressure to speak and write in English.

I. Speaking

Although Brian's previous responses to questions about his experience demonstrated how much he benefited from translanguaging for understanding science content, his opinion on translanguaging revealed a sense of conflict about relying on such support. When asked about his opinions of using both Spanish and English in the science classroom, Brian shared his opinion, saying that, "que debería solo usar un idioma *(I should only use one language)*". He explained this is because he wants "aprender. . . más del inglés *(to learn more English)*". However, when asked about his preferred language for learning science subjects, rather than prioritizing improvement in English, Brian opted for Spanish.

> Ms. Irene: Si pudieras elegir una clase en donde se habla solamente en inglés, o una clase en donde se habla inglés y español. ¿Cuál preferirías?
>
> *(If you could choose between a class where you only spoke English and one where you spoke both English and Spanish, which one would you prefer?)*
>
> Brian: Hablar? *(To talk?)*
>
> Ms. Irene: No, para aprender ciencias. *(No, to learn science)*.
>
> Brian: Español *(Spanish)*

Brian's responses highlight a shift in his preferred language based on the task at hand. When engaging with science, he favored Spanish, whereas for enhancing his English proficiency, he leaned towards English. This suggests that while he acknowledges the

benefits of Spanish for content learning, he also believes that using English will enhance his English language skills. There appears to be a sense of obligation for him to utilize English.

Similarly to Brian, West also acknowledged the positive role of translanguaging in aiding his comprehension of science content. However, he expressed a preference for English-only instruction as he aimed to improve his English skills. West explained that he felt the need for more English practice in class:

> Porque si yo hablo mucho en español, entonces, no estoy practicando más inglés. Entonces, tengo que intentarlo. . . porque cuando voy a estudiar algo de inglés, y estoy hablando en español, hablo mucho español. Entonces no voy a aprender nada, porque entonces solo voy a recordar el español y no el inglés.
>
> *(Because if I talk a lot in Spanish, then I'm not practicing more English, so, I have to try it. . . because when I am about to study something in English, and I'm speaking in Spanish, then I speak a lot of Spanish. So then, I am not going to learn anything, because I am only going to remember the Spanish and not the English).*

His statement showed that he is not content with speaking Spanish in the translanguaging class because he "*only remembers [the content] in Spanish*". He holds the belief that increasing his use of English would enhance his proficiency in the language. West's negative perspective on translanguaging in the science classroom is also linked to its divergence from the rest of the school. He expresses a desire to learn science in an English-only environment to integrate the English vocabulary and expressions learned into his other classes beyond Ms. Irene's. When asked about his language preference for science, he elaborated as follows:

> Inglés. Oh si, para aprender, digamos, porque en otras clases me puede servir. En las clases que no hablan español, entonces puedo usar eso, que ya sé [reconozco], que ya entiendo que están diciendo eso [entiendo el concepto]. Como que si me están explicando algo de la radiación, o como en algo de matemáticas ocupamos las ciencias.
>
> *English. Oh yes, to learn, like, because it could be helpful for me in other classes. In classes where we don't speak Spanish, so then, I could use this, that I know [recognize], and that I know what they are talking about [understand meaning]. Like if they explain something about radiation, or in math we use science.*

West felt that having English-only instruction in science class would aid in acquiring English vocabulary that he could apply in his other monolingual classes. His response highlighted the significant pressure he felt to improve his English skills, especially considering the absence of translanguaging support beyond Ms. Irene's science classroom. This experience seemed to influence West's perception of translanguaging practices in the classroom.

Similarly, Linsey expressed her belief that utilizing only English might be advantageous because other teachers were not proficient in Spanish, nor did they employ translanguaging techniques outside of Ms. Irene's classroom. When asked about her language use during notetaking, she responded as follows:

> Ms. Irene: Cuando tu tomas notas, anotaciones en la clase, tu escribes en español?
>
> *(When you take notes, annotations in class, do you write in Spanish?)*
>
> Linsey: No. *(No.)*
>
> So Lim: Why do you write in English?
>
> Ms. Irene: ¿Por qué escribes en inglés? *(Why do you write in English?)*
>
> Linsey: Para que entiende la maestra. *(So that the teacher understands.)*

The emergent bilingual students' responses revealed a complex relationship with translanguaging, wherein they acknowledged its potential benefits while also feeling conflicted about its limited availability. This discrepancy in translanguaging access across

the school environment, coupled with institutional linguistic norms, contributed to their discomfort with relying on translanguaging in Ms. Irene's class. Their aspiration to enhance their English proficiency, combined with the absence of translanguaging support beyond Ms. Irene's classroom, influenced their language preferences and decisions.

II. Writing

Students' language preferences for writing showed a similar pattern. Despite the option for Ms. Irene to assess their final reports in either English or Spanish, three of the four participants chose to translate their entire reports from Spanish to English. Only one student, West, integrated both English and Spanish in his final draft. This choice contrasted with their preference for writing HomeFun activities in Spanish.

During interviews, all four students voiced a strong inclination toward writing in English. Some even expressed dissatisfaction when initially drafting their reports in Spanish. For example, despite Carter's positive experience with translanguaging in learning science, he recalled feeling uncomfortable about writing his initial draft in Spanish:

So Lim: How was it to write this initial report in Spanish?

Carter: Un poco costoso porque quería escribir en inglés. *(A little bit hard because I wanted to write in English.)*

So Lim: Why did you want to write in English?

Carter: Para mejorar mi escritura y aprender cómo escribir las palabras. *(To improve my writing and to learn how to write the words)*.

When questioned about his experience writing the final draft in English, Carter's demeanor noticeably brightened. He expressed satisfaction, stating that the process had aided him in learning some English verbs through writing in English.

So Lim: Then, when you wrote your final draft in English. How was this experience?

Carter: Cool. Cool, because así aprendí a usar un poco más los verbos y escribir más palabras. *(Cool. Cool, because in this way, I learned to use the verbs a little more and to write more words)*.

So Lim: How did you write? Can you explain the process of writing it in English?

Carter: Usando Google Translate. *(Using Google Translate)*

Previously, Carter's perspective on writing in Spanish was positive when he considered it as a tool for learning science content. However, when he perceived writing as a chance to improve his English proficiency, he held a more negative outlook on using Spanish, reflecting Carter's belief that increasing his English usage would help enhance his English language skills.

Similarly, while Linsey previously exhibited a favorable attitude towards using Spanish for learning science, she expressed a preference for writing in English to enhance her proficiency in the language:

So Lim: If there is a choice to write in Spanish or English, which language would you choose?

Linsey: inglés. *(English.)* Porque si estoy escribiendo [en inglés] me quedan las palabras y yo puedo aprender más [inglés].

(English. Because if I am writing [in English], the words stick with me and I can learn more [English]).

As shown above, Linsey's response reflects her aspiration to enhance her English skills, influencing her choice of language for writing. Brian echoed similar sentiments, placing significant importance on learning English within the translanguaging environment.

In contrast to Linsey, Carter, and Brian, West expressed a distinct language preference. While he acknowledged the importance of learning English in the science classroom, he

also saw translanguaging as an effective method for English acquisition. Unlike his peers, who believed writing solely in English was optimal for improving their language skills, West found value in utilizing both languages in writing. He noted that using Spanish helped him complete sentences he struggled with in English:

> West: Quiero aprender inglés, y entonces lo intento a escribirlo. Para ver si lo puedo escribir bien. Los escribí un poco español y un poco inglés, porque yo intenté como. . . como mi method.
>
> *(I want to learn English, and so I try to write it. To see if I can write it well. I wrote a little Spanish and a little English because I tried like. . . like my method.)*

West's approach to writing distinguished him from his peers; he was the only student among the four emergent bilinguals to compose his final draft using both languages (Table 3). In contrast to Carter, Linsey, and Brian, West did not feel compelled to translate the entire draft from Spanish to English. Instead, he employed both languages as a writing method. Despite sharing a strong desire with his peers to enhance his English skills, West held a positive perspective on translanguaging's role in both learning science content and improving English writing.

Table 3. West's writing using translanguaging.

"...another goal of this project includes preventing thermal equilibrium because porque no queremos que la temperatura ambiente llege ala botella this lunchbox can successfully preven heat transfer by redaccion do la conduccion y radiaccion."

5. Discussion and Implications

5.1. Effects of Translanguaging in Learning Science and Family Engagement

The findings of this study suggest that translanguaging effectively supported the four emergent bilingual students in meeting science standards. The successful completion of the invention project and report writing by all four emergent bilingual students underscores the impact of translanguaging on content learning. Furthermore, despite variations in understanding demonstrated in their writing, all students exhibited comprehension of the science concepts taught in class. Linsey and Carter's reports even demonstrated higher-order thinking skills, indicating the transfer of knowledge from familiar to unfamiliar contexts [61,62]. They effectively applied concepts such as conduction, convection, and radiation to their lunchbox experiments. Linsey even extended this understanding to the concept of gloves, which she identified as a means to prevent conduction. In Carter's words, translanguaging enabled these students to "*understand better*" and focus on "*how sciences are*". Using translanguaging as a method provided these students with equitable access to science content and facilitated their active engagement in the learning process [22,63,64].

These findings are aligned with previous research demonstrating the positive effects of translanguaging for student comprehension and engagement [20,65–68]. According to Washington and Seidenberg [69], the challenges of learning academic content multiply for students who must learn in a different language than the one in which they are proficient. Translanguaging addresses this by enabling students to comprehend content to a similar extent as their English-proficient counterparts [66,68], thereby leveling the playing field for emergent bilingual students to grasp core content.

Another distinctive benefit of translanguaging that emerged from this study was family engagement. I argue that translanguaging had a significant role in advancing family involvement for the emergent bilingual students and could become a crucial tool to support school/family partnerships among language minority families. Numerous studies have underscored the importance of family engagement in students' academic achievement, motivation, and behavior in school [70–72].

However, even if parents desire this kind of engagement, language and cultural barriers can make it extremely challenging for language minority parents to contribute

their knowledge and experience to their children's schoolwork [73,74]. Translanguaging supported this by removing these unnecessary language restrictions, enabling students and parents to work together. When students were able to actively involve their parents in what they were learning at school and learn from them, it made science activities "cool" and "bien *(good)*," as expressed by Brian. This type of engagement extends beyond mere participation in school-led activities such as parent meetings and orientations [75]. This genuine family engagement can empower families "to take their place alongside educators in the schooling of their children, fitting together their knowledge of children, teaching, and learning with teachers' knowledge" [76] (p. 13).

5.2. The Significance of Collaborative Institutional Support and the Impact of Monoglossic Ideology on Students' Perception of Translanguaging Practices

This study also highlights the variability in students' attitudes toward translanguaging practices across different learning tasks and contexts. Notably, all four participants enjoyed engaging in translanguaging with their families during HomeFun activities, indicating a positive association with the social setting of the home and family. It is understandable that students would prefer to use their first language in their homes, where it is the primary language spoken.

At school, they expressed mixed feelings about translanguaging. Many research studies indicate that translanguaging enhances students' comprehension of subject matter and fosters positive attitudes toward academic learning [21,23,47]. Similarly, when focusing on learning science content, all four students acknowledged the benefits of translanguaging. However, their attitudes toward translanguaging shifted when considering the broader school setting. In social contexts where English was the only medium of instruction and the norm, they preferred English-only practices over translanguaging. In this setting, their focus on learning English became more pronounced, leading to a shift in their attitudes toward translanguaging from positive to negative (Figure 1).

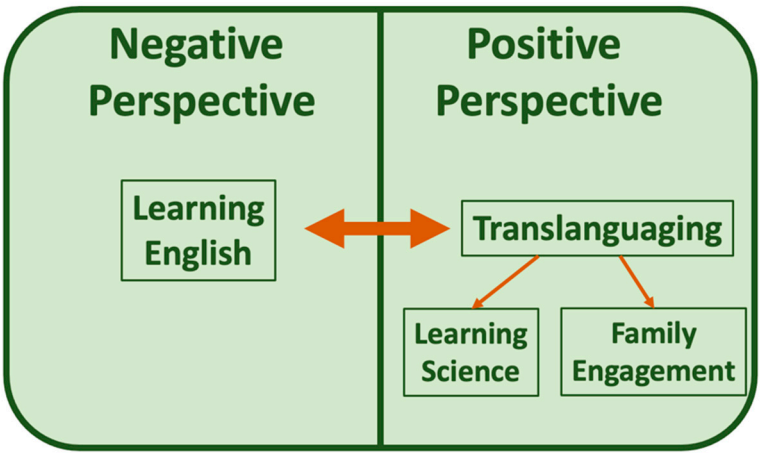

Figure 1. Students' perceptions of translanguaging.

The abrupt change in students' attitudes highlights the necessity of collaborative efforts to implement effective and successful translanguaging practices. Despite Ms. Irene's dedication to utilize students' languages as well as English and her phenomenal language skills, the lack of institutional support to promote translanguaging at the school level led to it being perceived negatively in terms of their English language development.

Additionally, the prevailing language ideology in school seemed to influence the students' perception of translanguaging practices. Despite experiencing positive outcomes in learning science content through translanguaging, all four emergent bilingual students expressed a preference for learning subject matters in English to improve their English skills. West even mentioned that any knowledge acquired in the translanguaging class is not valuable if it cannot be remembered in English: "*I am not going to learn anything, because*

I am only going to remember the Spanish and not the English". These findings corroborate previous research indicating that students internalize and adhere to monoglossic ideologies within monolingual school environments [4,5,36,66,77]. It is possible that these ideologies foster negative attitudes toward translanguaging practices and prompt students to prefer English-only learning settings over those based on translanguaging. These sentiments underscore the influence of monoglossic ideology in shaping students' language ideologies, encouraging them to prioritize English over their native language which again perpetuates monoglossic beliefs. It also demonstrates how the emergent bilingual students in this study were cognizant of linguistic power imbalances within the school environment and attempted follow the unspoken norm.

This study carries several implications. Firstly, there is a clear need for professional and structured institutional support to establish multilingual school environments. Such support is vital for ensuring that emergent bilingual students can fully reap the benefits of translanguaging practices while avoiding the absorption of monoglossic ideologies [66,75,77,78]. Collaborative efforts to develop multilingual schools will foster inclusive and supportive learning environments that cater to the needs of emergent bilingual students [79].

Secondly, it is important to listen to what students have to say about the educational and pedagogical practices that are applied to their education. Students' voices are often left out of these kinds of conversations because their opinions differ from those of the more powerful adults [80,81]. Yet, as primary stakeholders in their own educational outcomes, they have every right to contribute their insights and opinions to advance their learning [81]. Creating increased space for student voices can empower students as well as lead educators to "the new way of knowing" about what it means to teach and learn from students [81] (p. 92).

6. Limitations and Suggestions for Educators

A limitation of this study is the small sample size, consisting of only four students, all from the same country and sharing the same first language, Spanish. This lack of diversity limits the generalizability of the findings. To address this, future research should include a larger and more linguistically diverse sample. Additionally, varied data collection methods, such as questionnaires across different schools and classes, are necessary to better understand the impact of the translanguaging method. For future studies, increasing the sample size and incorporating diverse linguistic backgrounds, along with various data collection methods, will help generalize the results and enrich the understanding and applicability of the translanguaging method.

Another limitation is the applicability of the translanguaging teaching method for monolingual teachers and students who speak different L1s from the teacher. While it was a unique and valuable opportunity for the students to experience a translanguaging environment where two languages are spoken naturally and the teacher is fluent in both, not all teachers are able to speak students' first languages like Ms. Irene. Therefore, it is crucial to recognize the potential challenges that could emerge if students' first languages (L1s) differ from their teacher or if their L1s are less commonly known languages.

Considering such situations, we suggest that teachers construct a translanguaging classroom where the teaching philosophy revolves around respecting students' culture and language (79). Even if teachers do not speak their students' first language or students' languages differ from one another, teachers can still implement translanguaging strategies by thoughtfully designing their instruction to respond to the translanguaging pedagogy and guide students to continue building their languages [79]. García et al. [79] describe it as having a "translanguaging stance", where teachers hold the belief that "students must have access to all their linguistic resources at all times" (p. 55). For example, teachers can create a "multilingual ecology" that makes all students' languages feel welcome and visible by creating multilingual resources like posters, word walls, dictionaries, and multimedia content [79] (p. 63). This will create spaces where students' languages are used and

encouraged and allow students to explore learning content in both English and their first language.

In the same vein, promoting the importance of developing their first language, providing multilingual books, and introducing multilingual authors are great ways to create a translanguaging classroom [79]. Teachers can organize discussion groups and encourage them to collaboratively explore their first and second languages together. Creating multilingual assignments and homework is also beneficial, as demonstrated in the study; teachers can design assignments that allow students to use their first language to process and express their thinking, such as writing essays or completing projects in their first language.

In addition, it is very important to acknowledge the challenges that may arise when students' L1s differ from one another or if their L1s are less commonly known languages. In such scenarios, there is a risk that students with less common L1s may feel left out. To address this, teachers can adopt additional strategies to ensure inclusivity and effectiveness. Firstly, fostering a classroom culture that values and respects all languages equally can help mitigate feelings of inferiority among bilingual students [79,82]. This can be achieved through discussions, projects, and activities that highlight the importance of linguistic diversity [83]. Secondly, teachers can seek resources and support from the wider community, including parents, cultural organizations, and language experts, to better understand and integrate these languages and cultures into the classroom [48,84]. Finally, utilizing digital resources and instructional technology can provide access to a broader range of linguistic and cultural materials and support for both teachers and students [22,83,85].

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