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"It's How We Get Along" – Translanguaging in Middle-School Mathematics Class

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Abstract

This article explores the translanguaging practices of five middle-school emergent bilinguals in mathematics. Situated in a Spanish-English dual language school in Miami, Florida, this ethnographic case study utilized student shadowing as the principal method of data collection. Data sources included six months of classroom observations, students' mathematics work, and interviews with students and their mathematics teachers. Findings illustrate how translanguaging was not a random, haphazard experience among participants; rather students and their teachers transcended modes in a dynamic way that reflected their personal histories as members of Spanish-speaking families, as Latinas/os living in Miami, as members of a dual language school, and as individuals with different mathematics histories. This research underscores the multimodal aspects of translanguaging that students used to make sense of their mathematics learning. It highlights translanguaging as an asset-based pedagogy in its recognition of students' funds of linguistic knowledge. Pedagogical implications are provided for the teaching and learning of mathematics among emergent bilinguals.

Keywords: translanguaging, mathematics, Spanish-English, emergent bilinguals

Over half of the world's population is bilingual in that they regularly use two or more languages in their everyday lives (Grosjean, 2012). Baker and Wright (2021) noted that bilingual classrooms are those where (1) formal instruction fosters bilingualism and (2) bilingual children are present, but bilingualism is not fostered in the curriculum. This article presents a case of the former, mathematics classrooms in a dual language program where students access and develop their full linguistic repertoire of the named languages of English and Spanish. Specifically, this article describes the translanguaging practices of five middle-school Latina/o emergent bilinguals. The term "emergent bilinguals" (Escamilla, 2006; García, 2009) counters frequently-used deficient-sounding labels for language minority students in state-mandated English learning programs (e.g., English Language Learners [ELLs], Limited English Proficient [LEP], and English for Speakers of Other Languages [ESOL]). This term recognizes students' realities as bilinguals and situates them at the center of the multilingual communities in which they live.

Emergent bilinguals possess *funds of knowledge*–historically accumulated and culturally developed resources, skills, and practices embedded in students' households, family networks, communities, and schools (González, Moll & Amanti, 2005). Language is a fundamental fund of students, linked to their local histories and school-home-community contexts, and used as an instrument for social and intellectual development. Recognizing and affirming students' languaging practices rehumanizes students in that it values the human need for social recognition and a positive sense of self (Langer-Osuna & Nasir, 2016). It is from an appreciation of students' funds of linguistic knowledge that this research arises.

This study highlights translanguaging as a practice in mathematics classrooms during a time period of growth, accountability, and innovation. In the USA, emergent bilinguals comprise one of every ten students in K-12 schools, for which Latinas/os constitute 77% (National Center for Education Statistics [NCES], 2021). Between the academic years of 1997-1998 and 2015-2016, emergent bilinguals increased by 40% while the general student population increased by just 10% (NCES, 2015; United States Department of Education, 2015). Growth in emergent bilinguals has occurred during a period of academic pressure at state, national, and international levels. Emergent bilinguals must demonstrate proficiency in English language arts and mathematics through annual subject testing in English. Internationally, the USA ranks 31st in mathematics among industrialized nations (NCES, 2018), prompting national measures to increase the number of students who pursue STEM fields – science, technology, engineering, and mathematics.

With mathematics a priority, and annual testing in English a reality, schools must consider innovative ways of teaching and learning. They must take into account the mathematics experiences of students such as the Latina/o emergent bilinguals in this study. As Moschkovich (2002) echoes, "If mathematics reforms are to include language-minority students, research needs to address the relation between language and mathematics learning from a perspective that combines current perspectives of mathematics learning with current perspectives of language, bilingualism, and classroom discourse" (p. 189).

Translanguaging: Theory, Pedagogy, and Practice

Originally termed *trawsieithu,* Williams (1994) described the phenomena of translanguaging as one where teachers and students varied their language of input (reading or listening) and output (speaking or writing) within Welsh-English bilingual high school classrooms. It has emerged as an evolving concept in the scholarship on the teaching and learning of second language learners. Translanguaging challenges traditional views of language and literacy as isolated skills and areas of development. It encompasses hybrid language practices such as codeswitching (Blom & Gumperz, 1972), parallel speech (Pagett, 2006), and language brokering through interpretation and translation (Orellana, 2009; Tse, 1996). García (2011) notes that translanguaging is a natural practice among bilinguals who are already living amongst and between communities that are hybrids themselves. Bilinguals bring to this "translanguaging space" (Li Wei, 2011) their personal histories, experiences, environments, attitudes, beliefs, and ideologies, and cognitive and physical capacities. It is in this space where bilinguals can generate new identities, values, and practices.

Research highlights the benefits of translanguaging among teachers and students within bilingual education settings. Baker and Wright (2021) note that translanguaging can lead to both a deeper and fuller understanding of subject matter through linguistic reprocessing, and literacy development in one's weaker language. García (2011) observed translanguaging to occur among teachers and students in a Spanish-English two-way immersion kindergarten program in four ways: (a) to mediate understanding, (b) to co-construct and construct meaning, (c) to include and exclude, and (d) to show knowledge. Creese and Blackledge (2010)

conducted case studies across multiple Chinese Mandarin and Gujarati community language schools and found translanguaging practices allowed speakers to perform identities and transmit information using all linguistic signs at their disposal. Emphasizing translanguaging in essay writing, Canagarajah (2011) noticed that a dialogical revision process provided students with the opportunity to develop metacognitive awareness of their languaging practices. García and Kano (2014) observed differences in the way Japanese teenagers translanguaged in an English essay-writing class. Students at the beginning points of the bilingual continuum translanguaged to support learning, those further along on the continuum translanguaged to expand their cognitive and linguistic performance, and experienced bilinguals translanguaged more independently to self-regulate and enhance learning.

For emergent bilinguals, translanguaging has significant advantages for the learning of mathematics. Moschkovich (2007) highlights several aspects of mathematics classroom environments that are conducive to learning among bilingual students: (a) instruction and materials that allow students to choose the language they prefer for arithmetic computation, (b) an awareness of students' previous instructional experiences in mathematics, and (c) a view of codeswitching as a resource for students to communicate mathematically. Garrison and Mora (1999) note that when language is removed as an obstacle to learning mathematics, students can develop their conceptual knowledge. Once a concept is known, it becomes a vehicle for learning language. Garza (2017) showed translanguaging as a pedagogical tool that supports appropriation of mathematical meanings and discourse, and as a linguistic practice that allows fluidity and movement of the teaching and learning process. When teachers leverage students' bilingualism in instruction and discussion, they position emergent bilinguals as possessing linguistic knowledge. Students take on the role of agentive problem-solvers, and their bilingualism is elevated as an intellectual resource (Turner, Dominguez, Maldonado & Empson, 2013).

Emergent bilinguals mediate their mathematics understanding not only through language modes of reading, writing, speaking, and listening, but also through modes other than language. Such semiotic modes include images and gestures, as well as symbols, terms, and expressions unique to the mathematics register. Together, these modes contribute to a multimodal learning experience—one that Kress (2000) notes more accurately represents the current era of increasing technology. Resources such as overhead projectors, Promethean® boards, iPads, and digital textbooks comprise the 21st century classroom and contribute to students' range of mediational tools.

Methods

The larger ethnographic case study explores the Spanish speaking and writing of five Latina/o emergent bilinguals in a Spanish-English dual language middle school in Miami, Florida. The research site was selected because the researcher worked voluntarily at the school as a visiting teacher during the 2012-2013 academic year. Student shadowing was the principal method of data collection for this study. Soto (2012) conceptualizes shadowing as "reflecting upon a day in the life of a child or adolescent in English transition who may be experiencing school slightly differently than native English speakers" (p. 1). The researcher accompanied students to their Spanish instruction classes (e.g., Mathematics, Humanities, and Spanish) during a period of six months. This article describes the mathematics component of the study, calling attention to students' translanguaging practices, which were situated within broader socio-historical, regional, and institutional settings.

Miami: A Pan-American City

Miami has continued its historical beginning as a refuge for immigrants. From the 1930s until today, immigrant groups from the Caribbean, Europe, Central America, and South America have made Miami their home. Presently, 58% of its approximately 442,000 residents are foreign-born, and among the city's 72% Latina/o population, 73% are foreign-born (US Census, 2020). Large-scale Cuban migration began in 1959 after the rise to power of Fidel Castro. Miami's Latina/o population has since expanded to comprise groups originating from 20 different Spanish-speaking countries, including Nicaragua, Honduras, Colombia, Venezuela, Puerto Rico, and the Dominican Republic. With its geographical proximity to Central America, South America, and the Caribbean, and dominant industries of commerce, travel, and tourism, Miami has become known as the "Gateway of the Americas."

It does not take long for a newcomer to Miami to feel the presence of Spanish. The language is as much a part of the linguistic landscape (Shohamy & Gorter, 2009) as English, represented in the public sphere through audio, visual, and digital means. Spanish, in all its varieties, is seen on billboards, posters, window signs, graffiti, business and street names, electronic displays, and social media. The impact of Miami's Spanish media sources is expansive, every day reaching tens of millions of homes in the USA and throughout Latin America. Indeed, the presence of Spanish makes it a *lingua franca*, a defining characteristic of everyday life.

Coral Way: Research Site

Built in 1936, Coral Way is home to the oldest Spanish-English public bilingual program in the USA. Launched in 1963 as part of the US government's "Cuban Refugee Program," its dual language program has continued for more than a half century. The school motto is "*Dos idiomas, Dos mundos de oportunidad*/Two languages, Two worlds of opportunity." Coral Way is unique in that it welcomes all students residing in its school boundaries and all students participate in the dual language program. Students receive instruction in language arts, social studies, science, and mathematics by teachers proficient in the designated language, either English or Spanish. The language of instruction differs at the elementary and middle-school levels. At the middle school level, 40% of instructional time is in Spanish, including mathematics, Spanish language arts, and Humanities. Coral Way is a Title I school with a majority Latina/o faculty, staff, and student population mostly from Cuban, Caribbean, and Central American origins. At the time of the study, the school comprised 1500 students: 89% Latina/o, 8% White, 1% Black, and 2% Asian/Multiracial. Of the middle school students, 22% participated in the "English for Speakers of Other Languages" (ESOL) program. About 10% spoke first languages other than Spanish (e.g., Portuguese, French, Italian, and Arabic).

Middle-school mathematics at Coral Way is taught bilingually. The district supplied the school with two sets of mathematics textbooks and workbooks, one in English and one in Spanish, which allowed students to choose their language of preference. While there were no pre-established methods for bilingual instruction, mathematics teachers generally used Spanish or both languages for instruction and displayed the English version of the textbook on the Promethean® board or overhead projector. Each spring, students completed the Florida Comprehensive Assessment Test (FCAT) in mathematics, offered only in English. Throughout the year, teachers strove to prepare students for this assessment, emphasizing key vocabulary in English, downloading practice sheets, administering quarterly exams, and reviewing sample problems.

Participants

With assistance from the school's English language coordinator, five students were selected to participate in the study according to the following criteria: (a) they were part of the ESOL program; (b) they spoke Spanish as a first language; (c) they had a Basic/Intermediate level of

English proficiency; (d) they were interested in participating; and (e) their parents were supportive of the project. During the process of collecting consent and assent forms, parents and students were informed that information from the study would be protected and not shared in any way that would reveal the child's identity. Students could leave the study at any time. Although no formal attempt at representativeness was made, participants reflected school demographics. Students were of Cuban, Central American, and South American origin, and two-thirds were eligible for free and reduced-price lunch. Students varied in terms of mathematics level and time in the ESOL program as an emergent bilingual (EB) (see Table 1).

Table 1. Descriptive Characteristics of Students and Teachers in Mathematics Class

Student	*Grade*	*ESOL Level (1-4)*	*Number of Years as EB in US Schools*	*Course Title*	*Teacher's perception of class level*	*Teacher*	*Teacher's dominant language of instruction*	*2012-2013 Math FCAT score (1-5)*	*2012-2013 Math final grade*
Adrián	6	3	5	Math 1, Regular	Mid	Ms. Gómez	Spanish and English	3	C
Daniela	6	4	6	Math 1, Regular	Mid	Ms. Gómez	Spanish and English	4	B
Grecia	7	3	5	Math 2, Regular	Low	Mr. Valencia	Spanish	1	D
Julieta	6	1	2	Math 1, Regular	Low	Ms. Gómez	Spanish and English	1	B
Nico	7	2	1	Math 2, Regular	Low	Ms. Hernández	Spanish	3	B

Note: All names are pseudonyms.

Data Collection and Analysis

For the mathematics component of the study, data collection included 51 classroom visits and 63 hours of observation. Concurrent field notes were written while shadowing each student. The researcher sat next to or nearby the student and recorded field notes using a three-column format (Heath & Street, 2008), which indicated each student's Spanish language practices, classroom context, and researcher reflections. Data collection involved the use of triangulation through the use of multiple data sources. Triangulation increases the likelihood of sound findings and reduces the risk that conclusions reflect biases or limitations of a specific data source (Maxwell, 2005). In addition to observations, data sources included students' mathematics work as well as audio-recorded semi-structured individual interviews with students and their mathematics teachers.

Field notes and interviews were transcribed verbatim, and student work was maintained in its original form. Analysis of the data was inductive, grounded in particular pieces that were sorted and interrelated to understand student dynamics within a particular time and place (Dyson & Genishi, 2005). While I recognize students' translanguaging as leveraging all their meaning-making resources, I chose to highlight aspects of hybrid languaging in my coding scheme (e.g., codeswitching, parallel speech, and mirroring language). Data sources were uploaded and coded in ATLAS.ti®, and the researcher analyzed the data for patterns in students' language practices. These patterns are discussed in the following sections, first highlighted for each student and then further examined across all participants.

Findings

The following descriptions of each student highlight common language practices in mathematics and include representative examples. In some cases, students' written work is emphasized, and at other times, their speaking is underscored.

Adrián

Adrián was a friendly yet independent student who performed at an average level in 6th grade mathematics. When his academic progress dropped, Ms. Gomez, his teacher, would communicate with his mother who would encourage Adrián to complete his homework, improve his grades, and attend the school's weekly mathematics tutoring offered for students in the ESOL program. Adrián chose the Spanish version of the workbook, indicating that his mother could help him with homework. This year was his fifth year in the ESOL program, and he had varying mathematics class experiences that included three years of mathematics in English in a neighboring elementary school, and one year of bilingual mathematics during the previous year when he entered Coral Way.

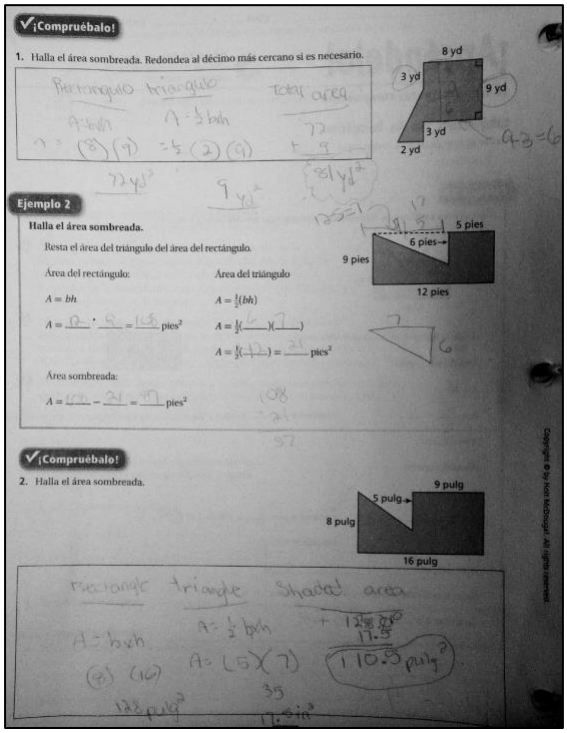


Figure 1. Mathematics Classwork.

Adrián completed his homework in Spanish with occasional responses in English (i.e. parallel writing), such as writing '78 pancakes/18 cups' when the problem stated *"panqueques"* and *"tazas."* His in-class participation was reflective of the constant translanguaging present in Ms. Gomez's instruction. When answering her direct or choral response questions, Adrián would sometimes mirror her Spanish, mirror her English, or engage in parallel speech, responding in English to her Spanish questions. Translanguaging was also evident in Adrián's written classwork. Figure 1 highlights fill-in-the-blank and practice problems for a unit on finding the shaded area of composite figures.

Adrián's classwork reflects translanguaging in its leveraging of named languages and modalities. In the first example, Adrián calculated separately the area of the rectangle and triangle. He labeled in Spanish, *"Rectangulo"* and *"triangulo,"* omitting the accents (*rectángulo* and *triángulo*), and then labeled in English "Total area." His formulas for area computation (A=bxh and A=½bxh) reflected English vocabulary and symbolic expressions, and he used numerical representation for his area computations. Adrián used the image of the composite figure to mediate his understanding of the base and height of the rectangle and triangle, circling important numbers to facilitate his computation.

In the middle example, Adrián relied on the image of the shaded figure to determine which numbers to write into the formulas for area of the rectangle and triangle. He used the figure to estimate the height of the triangle (more than 5) and then referred to the opposite side (12) in his final calculation of 7 for the height. He created his own image of a triangle, labeling his figure with the final numbers for base and height.

In the final example, Adrián referred to the shaded image to calculate the area of the rectangle and triangle, this time engaging in parallel writing in English, "Rectangle," "triangle," and "Shaded area." Similar to the first example, his formulas reflected English symbolic expressions, and he translanguaged when writing his abbreviated units of measurement, indicating *"pulg^2"* for the area of the rectangle, "in^2" for the area of the triangle, and *"pulg^2"* for the shaded area.

Adrián's classwork represents fluidity of language and multimodality—Spanish, English, formulaic, numerical, and imagery. Focusing only on the final shaded area responses would ignore the meaning-making resources he uses in problem solving.

Daniela

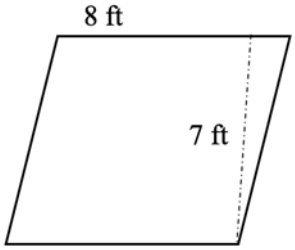
Daniela was an outspoken and well-liked student both inside and outside of mathematics class. She cared about achieving good grades, as did her parents. She regularly completed homework and asked questions in class when she needed clarification. She sat towards the front and helped Ms. Gomez progress through daily problems on the projector by scrolling up and down on the classroom laptop.

Daniela had been in the ESOL program for six years and came from an elementary school where mathematics was taught in English. In Ms. Gomez's 6th grade class, Daniela chose the English version of the workbook and used English to take notes, complete homework, ask questions, and socialize with classmates. Daniela occasionally used Spanish for one-word choral responses, yet her greatest utilization of the Spanish language was receptive, in the form of parallel speech. Excerpt 1 highlights Daniela's (D) choral response to Ms. Gomez's (MG) solicitation of calculating the area of a parallelogram. Students looked at the overhead projector where the problem was being displayed from the English version of the textbook.

Excerpt 1

MG: ¿Ocho por siete? (*Eight times seven?*)
D: Fifty-six.
MG: ¿Pies por pies? (*Feet times feet?*)
D: Square feet.

(On overhead projector)
3a. Find the area of the parallelogram.



In this exchange, Ms. Gomez questioned in Spanish, and Daniela responded chorally in English. Although they communicated in different languages, there was parallel understanding because both individuals have proficiency in Spanish and English. Daniela's parallel speech was representative of the translanguaging space that is Ms. Gomez's classroom. Ms. Gomez mixed languages effortlessly and credited her upbringing in Miami and childhood mathematics experience in Spanish-English bilingual programs as her natural "method." Through her first-hand experience, Ms. Gomez believed in the long-term benefits of "additive" (Lambert, 1975) bilingual education, where the belief is that learning a second language adds to one's repertory of skills at no cost to one's first language. She felt that

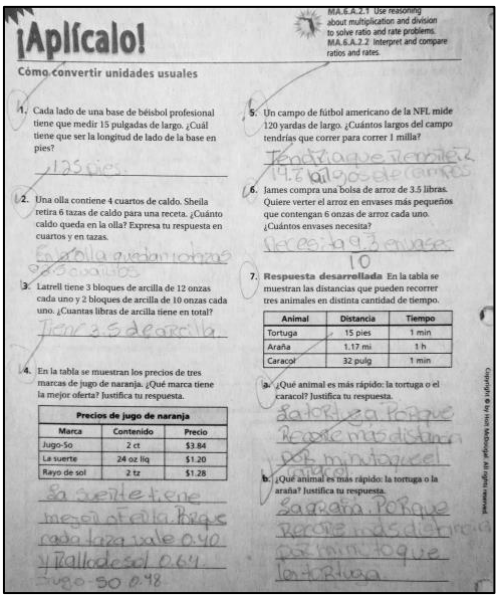
bilingual programs enhanced instruction more than monolingual education and allowed students to better express themselves. It is in this setting of acceptance and appreciation of multilingualism that Daniela felt comfortable engaging in parallel speech.

Julieta

Julieta was a diligent mathematics student who expressed interest and enthusiasm in learning the subject and appreciated the everyday usefulness of knowing mathematics (e.g., taxes, tips, and coupons). She found the subject easy and felt that her mathematics experience in Cuba prepared her well, stating, "What you do here in 6th grade, you do it there in 3rd grade." She had known her multiplication tables since first grade and indicated that, when she came to Coral Way the previous year, she had to learn a new way of doing multiplication and division that differed from the processes she had learned in Cuba. Julieta was in her second year in the ESOL program, and based on her previous year's FCAT score, had been placed in a low-level 6th grade mathematics class.

As time progressed, Julieta became more social in mathematics class, initially socializing in Spanish with Spanish-dominant classmates and later in English with more English-dominant classmates. She sat in the front of the classroom and frequently participated, sometimes interrupting other students' opportunities to respond. It was common for Julieta to make herself stand out during and after participation, with comments in English such as "Me, me, me!" and "Yes!" She often mirrored the language Ms. Gomez used and sometimes engaged in parallel speech. She chose the Spanish version of the workbook, and her classwork reflected the translanguaging evident in Ms. Gomez's instruction. For example, Julieta would sometimes write definitions and fill-in-the-blank words in Spanish and at other times in English, which was the language displayed on the overhead projector. Her homework was predominately in Spanish with occasional parallel writing (e.g., '45¾in' when the problem stated *"pulgadas"*). Figure 2 illustrates a homework assignment with word problems entailing the conversion of units of measurement.

Figure 2. Mathematics Homework.



¡Aplícalo!

MA.6.A.2.1 Use reasoning about multiplication and division to solve ratio and rate problems.
MA.6.A.2.2 Interpret and compare ratios and rates.

Cómo convertir unidades usuales

1. Cada lado de una base de béisbol profesional tiene que medir 15 pulgadas de largo. ¿Cuál tiene que ser la longitud de lado de la base en pies?

2. Una olla contiene 4 cuartos de caldo. Sheila retira 6 tazas de caldo para una receta. ¿Cuánto caldo queda en la olla? Expresa tu respuesta en cuartos y en tazas.

3. Latrell tiene 3 bloques de arcilla de 12 onzas cada uno y 2 bloques de arcilla de 10 onzas cada uno. ¿Cuantas libras de arcilla tiene en total?

4. En la tabla se muestran los precios de tres marcas de jugo de naranja. ¿Qué marca tiene la mejor oferta? Justifica tu respuesta.

Precios de jugo de naranja		
Marca	Contenido	Precio
Jugo-So	2 ct	$3.84
La suerte	24 oz liq	$1.20
Rayo de sol	2 tz	$1.28

5. Un campo de fútbol americano de la NFL mide 120 yardas de largo. ¿Cuántos largos del campo tendrías que correr para correr 1 milla?

6. James compra una bolsa de arroz de 3.5 libras. Quiere verter el arroz en envases más pequeños que contengan 6 onzas de arroz cada uno. ¿Cuántos envases necesita?

7. **Respuesta desarrollada** En la tabla se muestran las distancias que pueden recorrer tres animales en distinta cantidad de tiempo.

Animal	Distancia	Tiempo
Tortuga	15 pies	1 min
Araña	1.17 mi	1 h
Caracol	32 pulg	1 min

a. ¿Qué animal es más rápido: la tortuga o el caracol? Justifica tu respuesta.

b. ¿Qué animal es más rápido: la tortuga o la araña? Justifica tu respuesta.

Julieta's homework reflects translanguaging in her use of Spanish, numbers, and mathematical calculations to successfully interpret, solve, and respond to arithmetic word problems. She read each problem in Spanish and wrote her calculations on scrap paper (not shown), first determining whether to convert from small (e.g., *"pulgadas"* 'inches') to big (e.g., *"pies"*

'feet') and apply division, whether to convert from big (e.g., *"cuartos"* 'quarts') to small (e.g., *"tazas"* 'cups') and use multiplication, or whether to apply several operations (e.g., multiplication and subtraction).

Julieta leveraged multiple modes in problems four and seven as she used the tables to mediate her understanding of how to solve the problems. She relied on the tables for several pieces of information such as the title, column and row labels, and units of measurement that were embedded in her calculations and answers. These problems represented comparisons of inequality (e.g., *"¿Qué marca tiene la mejor oferta?"* 'Which brand is the better deal?' and *"¿Qué animal es más rápido: la tortuga o el caracol?"* 'Which animal is faster: the turtle or the snail?'), and involved multiple steps for Julieta of first finding a common unit of measurement, and then converting, comparing, and finally justifying her answer. In addition to drawing from Spanish, numbers, and mathematical operations, Julieta's reading of the word problems included cultural mediation as she comprehended the meaning of US cultural nuances such as "NFL" (National Football League) and the names "Sheila," "Latrell," and "James."

Julieta's homework served as a tool to develop biliteracy. Responses demonstrated practice with syntax and the incorporation of vocabulary from workbook questions. As several of the problems involved justifying one's answer, Julieta's writing reflected practice with conveying common Spanish constructions in the mathematics register, such as *"La Tortuga. Porque recore más distancia por minuto que el caracol."* 'The Turtle. Because it covers more distance per minute than the snail.' Her writing also played with grammatical and spelling conventions of the Spanish language, at times inserting accents (*más*), other times omitting accents (*tendria* instead of *tendría*) and letters (*recorer* instead of *recorrer*), or interchanging letters with the same sound (*Rallo* instead of *Rayo*), all examples of words included in the word problems. This flexibility with language shaped and was shaped by the translanguaging space of the mathematics classroom.

Nico

Nico was a hardworking mathematics student and very comfortable with the subject. It was his first year in a US school, and he had been placed in a low-level class with many peers who were less enthusiastic than he was about learning mathematics. Despite these potential barriers, Nico excelled at mathematics as a result of the bilingual nature of the class, his familiarity with mathematics vocabulary in English, and his own internal motivation and enjoyment of the subject. Of the three bilingual Spanish-English schools he attended in Honduras, he learned mathematics in English in two of them. In Ms. Hernández's 7th grade mathematics class, Nico chose the English version of the workbook, indicating that his mother wanted him to practice English. He regularly completed homework and responded to written word problems mostly in English with occasional codeswitching, either intrasententially in the same sentence, such as "Jerry earns 210 *dolares con esa cuota*" 'Jerry earns 210 dollars with that rate', or responding in Spanish to one problem and in English to another. He copied notes and definitions from the board in English, the language projected.

Although Nico wrote primarily in English, he engaged in oral participation primarily in Spanish. He used Spanish to ask questions, communicate with classmates, and respond to Ms. Hernández's instruction, which was almost entirely in Spanish. To say that Nico's participation was frequent would be an understatement. Nico participated all the time, and like Julieta, he would often shout approval for himself after he called out informally or answered questions formally, such as "Yes!," *"¡Sabía!"* 'I knew it!' and *"¡Lo acabo de decir!"* 'I just said it!' Nico not only replied with the answer, but he was typically the only one in the class explaining the reason for the answer. Excerpt 2 shows Nico's (N) choral responses as part of a lesson on

scientific notation. Ms. Hernández (MH) has projected the definition in English and an accompanying example on the Promethean® board.

Excerpt 2		(On Promethean® board)
MH:	¿Para qué usamos la notación científica?	Scientific Notation –
	Why do we use scientific notation?	scientific notation is a kind of
N:	Para escribir los números largos en forma corta.	shorthand that can be used to
	In order to write long numbers in short form.	write large numbers.
MH:	¿Por qué es 10^7? Yo quiero que me lo investiguen.	
	Why is it 10^7? I want you to investigate this for me.	Ex: 17,900,000 = 1.79 x 10^7
N:	Porque hay siete números después del punto decimal.	
	Because there are seven numbers after the decimal point.	

This example illustrates Nico's use of translanguaging to actively participate in class. The languages of input and output varied. Nico mediated his learning of the purpose of scientific notation through reading the definition in English from the board and responding chorally in Spanish. Rather than indicating a literal translation of the written definition, Nico used his own words to describe scientific notation, a practice that Ms. Hernández often suggested to students in class.

Nico's explanation of why 7 is the exponent represents another tactic of Ms. Hernández's teaching, which is the encouragement of mathematics reasoning. In particular, she provided the class with examples of cognitive strategies for remembering how to set up and solve mathematics problems and encouraged students to think of their own strategies. She often called students up to the board to work on problems and viewed students' errors as opportunities to review methods. Ms. Hernández's emphasis on reasoning came from her mathematics education and teaching experience in Colombia where students learned how to determine formulas and the reason behind the formulas. She believed that students benefitted from understanding the theory and that this foundation was lacking in the teaching of mathematics in the USA, where students are often provided with formulas. With both an emphasis on reasoning and a multilingual environment, Nico's translanguaging helped to ensure that his mathematics competence did not go unnoticed. Ms. Hernández recommended that he be placed in Algebra in 8th grade, a fast-track path that would allow him to skip the academic year of Pre-Algebra, which his classmates would take.

Grecia

Grecia was a quiet, respectful student who received motivation from home to excel in school. She cared about achieving good grades in mathematics but indicated that she wanted to do well with minimal effort. Despite her goal, Grecia received mainly Cs, Ds, and Fs on graded assignments in Mr. Valencia's 7th grade mathematics class. Similar to Nico's class, Grecia's class was considered low-level on several interrelated accounts: (1) one-third of students had "Intensive Math," an extra period to improve their previous year's FCAT mathematics score; (2) one-third attended "Math Recovery," an after-school program and last-chance effort to recuperate failing sixth grade (and mathematics); and (3) half of the students, including Grecia, had a low-quality 6th grade mathematics experience (e.g., substitute teachers and poor instruction). Thus, classroom morale, participation, and academic achievement were generally low in Grecia's class. While Grecia sat in the front of the class, her attention was neither full nor consistent, and she was often distracted from the lesson by peer comments, peer disinterest in mathematics, and her own daydreaming.

Grecia had been in the ESOL program for five years and, like Daniela, had come from an elementary school where mathematics was taught in English. She chose the English version of the workbook, indicating that her father, who was English-dominant and at home in the

afternoons, could help her with homework. In Mr. Valencia's class, Grecia used English to socialize with friends and fill out tests, quizzes, and worksheets, which were in English. Aside from completing tests and quizzes, writing was not a common class practice. For example, Mr. Valencia did not embed note taking or homework correction into students' daily activities. Therefore, Grecia and her classmates spent very little time writing in mathematics. With regard to oral participation, Grecia rarely initiated participation, and when she did, it was typically unrelated to mathematics theory and computation and more about seeking clarification in Spanish for which homework pages had been assigned. During class, when Grecia responded to Mr. Valencia's questions, she would mirror his language of instruction, which was almost entirely in Spanish. Excerpt 3 illustrates communication between Liam (L), who sits in the same group as Grecia, Grecia (G), Mr. Valencia (MV), and a female student (F) regarding a review lesson on fractions. Mr. Valencia has written the answer to a problem on the Promethean® board.

Excerpt 3 (On Promethean® board) -93/10 + 41/8 = -167/40

1	L:	[To Grecia] ¿Entendiste? *Did you understand?*
2	G:	No.
3	MV:	[Overhears] A ver Grecia, ¿Son fracciones similares? *Let's see Grecia, Are they like fractions?* [Referring to -93/10 and 41/8]
		Multiple students saying "No"
4	G:	No.
5	MV:	¿Por qué no? *Why not?*
6	G:	Porque son mixed numbers. *Because they're* mixed numbers.
7	MV:	No son mixed numbers. ¿Por qué no son fracciones comunes? Why aren't they common fractions? *They aren't* mixed numbers. *Why aren't they common fractions?* Why aren't they common fractions?
8	G:	Porque the negative. *Because of* the negative.
9	MV:	No. ¿Quién puede ayudar a Grecia? No. *Who can help Grecia?*
10	F:	Porque el denominador es diferente. *Because the denominator is different.*
11	MV:	Porque el denominador es diferente. ¿Ves? *Because the denominator is different. Do you see?*
12	G:	Okay.
13	MV:	Hay que encontrar un denominador común. *You have to find a common denominator.*
14	G:	[Nods in agreement]

In this example, Grecia translanguaged to fully participate in the dynamic conversation, which started between peers and transitioned into a class lesson. Various languages, both verbal and non-verbal, as well as modalities were evident among its speakers. Grecia mixed Spanish and English (6), stating, "*Porque son* mixed numbers," a vocabulary term repeated by Mr. Valencia throughout the class in English. After hearing Mr. Valencia codeswitch (7), first intrasententially and then intersententially to emphasize his question through translation, Grecia indicated "*Porque* the negative" (8) as she read and interpreted the minus symbol as a

negative sign. Although incorrect in her responses, Grecia translanguaged along with her teacher and peers in her effort to understand unlike fractions.

Discussion

This study highlighted the translanguaging experiences of five middle-school students in bilingual mathematics classes. Its ethnographic approach helped to expose students' funds of linguistic knowledge accumulated from their unique cultural experiences as members of Spanish-speaking families of various countries of origin, as Latinas/os living in Miami, as students attending a dual language school, and as mathematics learners with different mathematics histories. Furthermore, this study *re-presents* students learning English as a second language as emergent bilinguals who access and develop their full linguistic repertoire.

Students in this case study mediated their understanding of mathematics through translanguaging. They relied not only on Spanish and English language modes (i.e. speaking, listening, reading, and writing), but also on other modes, such as imagery (e.g., shaded-area figures) and gestures (e.g., nodding). Utilization of modes was not an isolated pick-and-choose experience; rather students flowed between and within modes in a dynamic and fluid languaging practice. They brought to the classroom their existing linguistic and cultural resources that guided their mediation and positioned them as active learners.

Students' oral participation tended to mirror the teacher's dominant language of instruction, which in Ms. Gomez's class was both Spanish and English. Her own translanguaging allowed students to feel comfortable using their full linguistic repertoire. Students' in-class writing was greatly influenced by English, the dominant written language displayed on the Promethean® board or overhead projector. Students would often mirror English in their writing or, when responding to workbook pages in Spanish, would codeswitch or use parallel writing.

Indeed, the mathematics component of the school's dual language program facilitated students' development of bilingualism and biliteracy. Students who had received prior mathematics instruction in English were introduced to the mathematics register in Spanish. Students who had received prior mathematics instruction in Spanish were able to continue and build upon Spanish as an intellectual resource. Furthermore, school materials in Spanish and English offered students the opportunity to develop literacy in both languages, including practice with grammatical and spelling conventions. For some students, their workbook was in a familiar language from previous mathematics experiences. For others, like Adrián and Nico, they were able to develop mathematics literacy in their weaker written language. Consequently, Nico's practice with the English version of the workbook and his familiarity with mathematics vocabulary in English may have been a factor in the mid-range mathematics FCAT score (3) he received at the end of his first year in a US school.

The translanguaging experiences of students in this study were context-bound. Students were fortunate to experience the additive aspects of a dual language program that has been operating for over five decades in a city where Spanish has status. Their mathematics teachers were all native Spanish speakers who believed in and supported the school's aim for students to become bilingual and biliterate. Teachers viewed students' translanguaging as a right because they viewed students' bilingualism as a resource (Ruiz, 2010). As a result, teachers created a "zone of comfort" (Vélez-Ibáñez & Greenberg, 1992) where students felt free to express themselves and experiment with language while they learned mathematics. Students' mixing of named languages and modes was common practice. "It's how we get along" as one student stated in response to why she mixed Spanish and English. Although not documented as formal policy, students' translanguaging was, as Levinson, Sutton and Winstead (2009) indicate, a policy as

a practice of power. Their translanguaging extended and was facilitated by their surroundings as the norm.

Pedagogical Implications

Insights from this study may be informative to the teaching and learning of students in bilingual settings. Recalling Baker and Wright's (2021) definition of bilingual classrooms as those where bilingual children are present, translanguaging happens among emergent bilinguals, whether students are part of additive or subtractive bilingual environments. Students mediate their understanding through accessing their funds of linguistic knowledge. Mathematics teachers can consider the dynamic nature of translanguaging and build upon students' bilingualism as an intellectual resource. Whether or not teachers are bilingual, they can ensure language support is in place. Recommendations include understanding students' previous mathematics experiences; allowing students to choose their language of materials; accepting translanguaging in oral participation and in writing; utilizing different modes of teaching and learning (e.g., imagery and technology); providing or creating bilingual materials (e.g., textbooks, mathematics dictionaries, and vocabulary charts); encouraging students to share their thought process; inviting more English-proficient speakers to serve as translators; and facilitating cooperative working groups among emergent bilinguals.

Mathematics teachers should be aware of potential challenges when teaching emergent bilinguals. As observed in the case of Grecia, instruction in Spanish is not enough to create an optimal learning environment. Teachers need to provide opportunities for students to be active mathematics learners. Possibilities include facilitating collaborative learning, asking students to share their mathematical reasoning, inviting students to review mathematics problems in front of the class, engaging students in choral response, encouraging note taking, and giving students ownership of their own homework correction or that of a peer. Middleton and Spanias (1999) note the importance of the middle years in influencing students' motivations toward mathematics. They suggest that teachers establish consistent instructional practices and facilitate students' understanding of the applied nature of mathematics by creating mathematics problems that relate to students' lives.

Furthermore, teachers should understand that initial placement of immigrant students in mathematics classes may not accurately reflect students' mathematics knowledge, as observed in the cases of Julieta and Nico. Year-to-year continuation of lower placement among emergent bilinguals can be exacerbated by students' scores received on annual state mathematics exams given in English. Gutiérrez (2002) calls attention to institutional forms of segregation (e.g., tracking and separate bilingual education) as factors affecting student placement in mathematics. Schools should consider initial mathematics assessment measures in students' first language, keeping in mind that multiplication and division processes may be different in other countries. At the classroom level, mathematics teachers must become advocates for emergent bilinguals placed in mathematics classes below their academic level. They should be prepared to provide students with more intensive material or recommend them for higher-level mathematics classes. With these recommendations in mind, along with an awareness of translanguaging as a practice of power, educators can create classroom environments that are conducive to the learning of mathematics among emergent bilinguals.

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