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Teaching Math to Newcomer Multilingual Learners: The Case for Teaching Diverse Math Practices

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Cover Page Footnote

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**Teaching Math to Newcomer Multilingual Learners:
The Case for Teaching Diverse Math Practices**

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Abstract

Multilingual learners (MLs), also referred to as English learners (ELs) in US K-12 public schools, and specifically newcomer MLs who have been in US schools for 2 years or less, are expected to learn the English language and reach grade level standards as their monolingual English-speaking peers. Mathematics education in the US has struggled over the years to achieve higher levels of math achievement for all students and for MLs. In this innovation in practice, we present how Ms. Shelley (a pseudonym), a math high school teacher incorporated her newcomer MLs diverse math practices in her teaching.

Keywords: Multilingual Learners (MLs); English Learners (ELs); Math Education for Newcomer Students; Diverse Math Practices; Culturally Responsive Teaching; Algebra I Instruction for MLs; Innovative Math Pedagogy

Introduction

Newcomer MLs in US schools come from a variety of countries from all over the world, with recent refugees and immigrants from countries that have experienced instability (Sugarman, 2023). In US public schools, multilingual learners (MLs) identified as English learners (ELs), and specifically newcomer MLs who have been in US schools for 2 years or less, are expected to learn English and reach content area grade level standards as their monolingual English-speaking peers (Council of Great City Schools, 2016). Nationwide, in the US, the MLs subgroup are behind their peers in math achievement as NAEP scores indicate (The Nation's Report Card, 2019).

Mathematics education in the US has struggled over the years to achieve higher levels of math achievement for all students and for MLs in particular (The Nation's Report Card, 2019).

The literature on teaching mathematics to MLs is mostly focused on teaching the vocabulary, building background knowledge, and providing students opportunities to learn, use, and practice math concepts and the language that goes with them (see Lee et al., 2013; Zhao & Lapuk, 2019; Turner et al., 2013). Not so much focus has been on what math practices MLs already have that might differ from the way math is taught in US schools.

Math is important for all students' (including for MLs) success and post-secondary attainment. Math exams are part of required high school graduation (Sugarman, 2021) which consequently act as gateways to post-secondary opportunities. The sequence of math courses students can take in high school requires Algebra I as one of their first math course required for graduation. Teaching math in general, be it high school math such as algebra or math in earlier grades to MLs is at times described as "easy". Math is wrongly perceived as a universal language (Moschkovich, 2010), when in fact math is not easy or a universal language as some might consider (Parker Waller & Flood, 2016; Wamsted, 2022). As such, teaching math to MLs in general and specifically to ML newcomer students might involve new innovative practices.

Teaching Context

This innovation in practice described below was part of a larger teaching-research project that Ms. Shelley, a pseudonym, a Math teacher, has conducted as part of a local university supported action research program. Elena (first author) is a faculty at the university and supported Ms. Shelley with her project. Elena and Ms. Shelley have worked together for a year on this project and collected the following: 1) weekly or bi-weekly classroom observation notes; 2) picture of classroom materials; 3) email reflections between Ms. Shelley and Elena. The collected data was used to identify and present the practice in innovation below.

Ms. Shelley is a Math and English as a second language (ESL) certified high school teacher. Ms. Shelley teaches Algebra I to ML newcomer students at Newport Newcomer School (a pseudonym), a newcomer school for MLs in an urban area in the US. Algebra I is the first math course that students in middle schools or high schools take as part of their required math credits for high school graduation. Ms. Shelley at the time of the study (2021-2022 school year) had 10 years of experience teaching math and 9 years teaching math (including but not limited to Algebra I, Algebra II, and Geometry) specifically to newcomer MLs at Newport Newcomer School. For the 2021-2022 school year, when the innovation in practice took place, the MLs in Ms. Shelley's class spoke a variety of languages, came from diverse countries around the world and had a range of schooling experiences, including some with interrupted education due to war and/or refugee status. There were students from Iraq, Afghanistan, China, Mexico, Honduras, China, India, and Tanzania. All students in her class had been in US schools for less than 2 school years.

Reason for the Innovation

Ms. Shelley considers that math is not a universal language by any means. Ms. Shelley, as well as other math teachers of MLs, noticed that some MLs come to the classroom with different math skills such as how to solve math problems or do long division, that do not conform with how mathematics is being taught in the US (see The ESL Nexus, 2017), thus confusing the students. For example, $8092 \div 4 = 2023$ is universally accepted, but how you solve and set up that long division to get to 2023, is not a universal process across countries (see Figure 1.) Observations as this one, has led Ms. Shelley be a careful observer of MLs' math practices which she has documented over the years and subsequently used in her teaching.

This paper uses and aligns with the following definition of math practices as:

culturally organized, [which] involve symbol systems, and are related conceptually to other mathematical practices. From this perspective, mathematical practices are not only cognitive – i.e., involving mathematical thinking and reasoning – but also social and cultural – arising from communities and mark membership in communities – and semiotic – involving semiotic systems (signs, tools, and their meanings) (Moschkovich, 2021, p. 9).

Additionally, teachers need to “creat[e] opportunities for constructive engagement in mathematics and build... on students’ social and cultural knowledge and life experiences to develop not only conceptual understanding and related language competencies, but also the belief that mathematics is worthwhile, sensible, and feasible” (Council of Great City Schools, 2016, p. 5). And this is the innovation Ms. Shelley has set up to do: 1) observe her MLs math practices and 2) subsequently use them in her teaching to support her learners’ math learning.

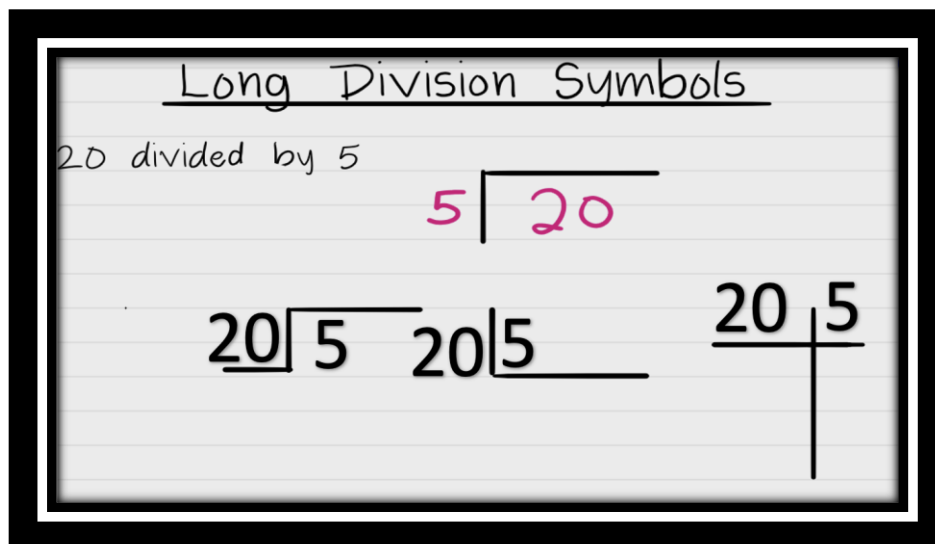


Figure 1: Long division diverse set ups

Description of the innovation

As noted earlier, Ms. Shelley has paid attention to what the students bring to class and document their way of doing math for two reasons: 1) out of pure math literacy curiosity for her own learning and enrichment and 2) to be able to leverage students previously known math skills. Ms. Shelley observed and took notes on the ways her students did math, took pictures of their work and asked students questions whenever she saw a method she was not familiar with. She organized her observations and notes in a way that was easy for her to review and check as needed.

One example of what Ms. Shelley had learned from her newcomer MLs is the diverse math practices one can do such as long division (see figure 1). Different set ups of the two numbers involved long division are correspondent to diverse practices of doing division.

Using what she learned and based on teaching practices and strategies she knew, Ms. Shelley decided to teach her MLs different ways (some of which learned from her students) of solving equations or methods. Some of the methods were learned from her students and some were methods she has always taught in an Algebra I class. So, the innovation consisted of organizing what Ms. Shelley knew about solving equations from her training and experience as an Algebra I teacher with what she learned from her students and planning learning experiences in which students experience, learn, try and later decide which method of solving equations works for them the best.

Method 1 (see Figure 2, which Ms. Shelley called the “Western” method) is the method taught in Algebra I in US schools is when the teacher asks the students to “move the variable to one side”. Method 2 (see Figure 3), which Ms. Shelley called the “Eastern” method, is a method Ms. Shelley learned from MLs from Syria, Afghanistan, Pakistan, and Nepal. In this method, like terms such as all numbers are grouped on one side and when the terms are moved, they change

signs. Method 3 (see Figure 4) is the “College” method, and it is labeled this way because it is a combination of the previous 2 methods. Method 4 (see Figure 5), the “Technology” method, uses the Texas Instruments calculators. The technology method is new to most if not all MLs in Ms. Shelley’s class, as mental math, rather than calculators are preferred in math classes in countries where most of the MLs at Newport Newcomer School come from.

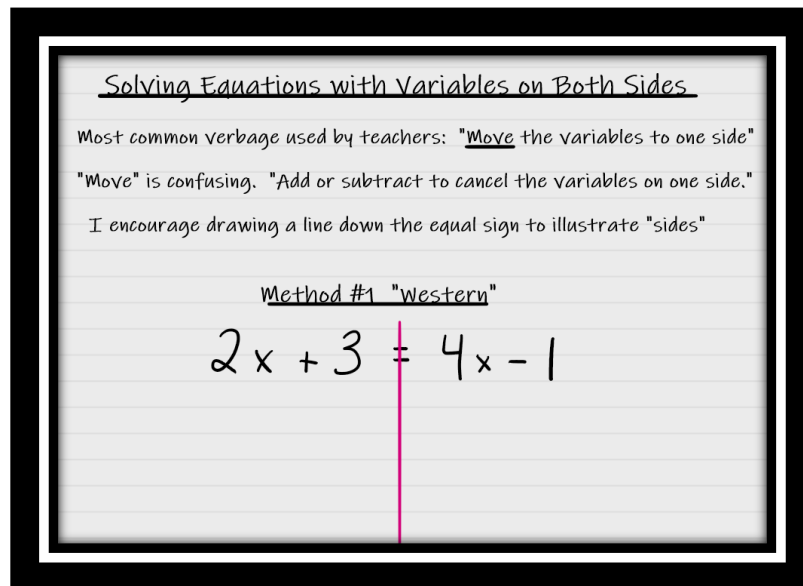


Figure 2: Western Method

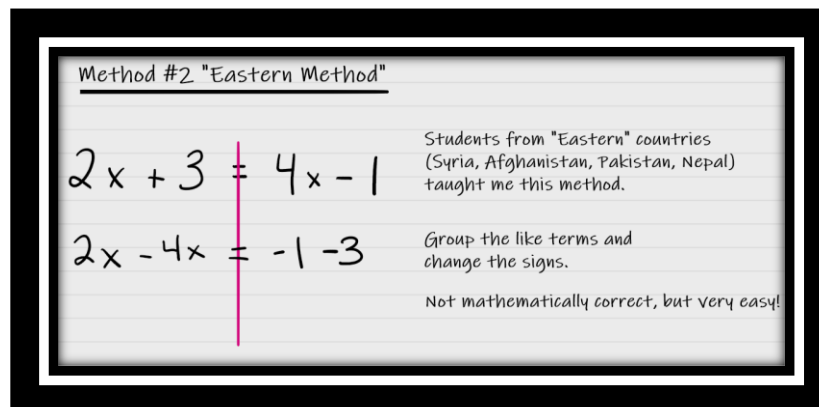


Figure 3: Eastern Method

Method #3 "College Method"

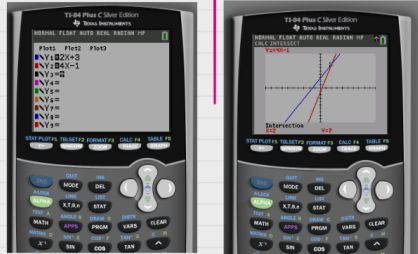
$$\begin{array}{r}
 2x + 3 = 4x - 1 \\
 + \quad -4x - 3 \quad = \quad -4x - 3 \\
 \hline
 -2x \quad = \quad -4
 \end{array}$$

I called it the "College Method" because we are combining steps.

Figure 4: College Method

Method #4 "Technology"

$$2x + 3 = 4x - 1$$



1. Enter each expression in Y=
2. Find the intersection point of the graphs.
3. The first coordinate is the answer. "x="

Figure 5: Technology Method

Reflection

By paying attention to what her ML newcomer students knew, Ms. Shelley became more knowledgeable in different math practices as well as more versed in teaching her students different ways to do math. Ms. Shelley considered that she needed to provide students multiple avenues for success in which she leveraged some of the math the students brought with them, but also taught them math literacy skills which conform to US methods, such as Method 4 which requires the students to learn how to use the Texas Instruments calculators.

This innovation, which is more of a teaching philosophy for Ms. Shelley, pays attention to students' math practices and leverages those. Ms. Shelley motto is "Math is not a Universal Language". From her experience with MLs she has learned math practices can be just as diverse as her students are. Teaching how to solve equations in four different ways took both intentional planning and time, but Ms. Shelley said "it was totally worth it". She noted she might not be able to include all math practices she observes and learns from her MLs for each unit and topic such as for adding fractions or graphing functions. This decision is made due to a variety of external factors such as time restrains stemming from school schedules, yearly state tests and increased class size, but definitely something Ms. Shelley continues to pursue. Ms. Shelley is committed to learning math practices from her students and leverage those to support their learning by incorporating them in her instructional practices.

Future pedagogical directions

For Ms. Shelley and other math teachers who teach MLs who come from a variety of cultures, it is important to pay attention and leverage the math practices the students bring to the table to honor their knowledge and skills and build new math practices and skills based on what they already know. Also, this innovation attempts to bust the myth that "math is a universal language" and remind teachers of the work math teachers who teach MLs have to do.

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