When Cultures Collide: Preparing to Teach Mathematics to Culturally Diverse Students

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Collision - an encounter between particles (such as atoms or molecules) resulting in exchange or transformation of energy.
https://www.merriam-webster.com/dictionary/collision

A *collision course* is if two or more people or groups are on a collision course, they are doing or saying things which will cause a disagreement or problems between them.
https://dictionary.cambridge.org/us/dictionary/english/collision
In mathematics classrooms, cultural collisions may look like this.
Causes of Classroom Collisions

- The changing demographics in schools.
- Teachers are unaware of the ways in which culture influences mathematics teaching and learning.
- Teacher preparation programs are not preparing teachers to work in culturally diverse mathematics classrooms.
Overview

◦ Trends in US Schools and Teacher Preparation
◦ Description of CAM Up!
◦ Preliminary Findings on Classroom Collisions
◦ Wonderings and Questions
Demographic Trends

- Public schools in the United States (US) are becoming more diverse.
- The number of Black and Hispanic students, English Language Learners (ELLs), and students living in poverty enrolled in U.S. public schools has increased.
- At the same time, the teaching populations is about 84% White.
Percentage Distribution of Teachers in Public Elementary and Secondary Students by Instructional level and Sex

Percentage Distribution of Teachers in Public Elementary and Secondary Students enrolled by Race/Ethnicity

Distribution of Public School Students enrolled in Pre K – 12th grade by Race/Ethnicity

Percentage of Public School Students who were English Language Learners, by grade level: Fall 2017

Percentage Distribution of Public School Students by School Poverty Level

- Low poverty: 45% (1999-2000), 24% (2010-11)
- Mid-high poverty: 16% (1999-2000), 27% (2010-11)
- High poverty: 12% (1999-2000), 20% (2010-11)
Distribution of *Teachers* in Chile according to gender over the years

Gráfico 1. Evolución de docentes en Chile según sexo, 2000-2018

Fuente: Unidad de Estadísticas, Centro de Estudios, Ministerio de Educación.
Distribution of Students in Chile according to gender and level of education

<table>
<thead>
<tr>
<th>Level of Education</th>
<th>Hombre</th>
<th>Mujer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media TP ciclo diferenciado</td>
<td>52,6%</td>
<td>47,4%</td>
</tr>
<tr>
<td>Media HC ciclo diferenciado</td>
<td>46,8%</td>
<td>53,2%</td>
</tr>
<tr>
<td>Media TP ciclo general</td>
<td>56,2%</td>
<td>43,8%</td>
</tr>
<tr>
<td>Media HC ciclo general</td>
<td>49,3%</td>
<td>50,7%</td>
</tr>
<tr>
<td>Básica especial</td>
<td>62,4%</td>
<td>37,6%</td>
</tr>
<tr>
<td>Básica regular</td>
<td>51,3%</td>
<td>48,7%</td>
</tr>
<tr>
<td>Parvularia especial</td>
<td>58,3%</td>
<td>41,7%</td>
</tr>
<tr>
<td>Parvularia regular</td>
<td>49,3%</td>
<td>50,7%</td>
</tr>
</tbody>
</table>

Fuente: Unidad de Estadísticas, Centro de Estudios, Ministerio de Educación,
Education in Chile

Immigration in Chile

According to the last national census (2017), the immigrant population increased from 0.81% in 1992, to 1.27% in 2002, and to 4.35% in 2017. The following graph shows the distribution of immigrants in Chile according to country of origin.
Background

◦ The changing demographics of US public schools have placed increased attention on preparing preservice teachers to teach culturally, linguistically, and economically diverse student populations.

◦ In mathematics education this is particularly important given the differential achievement of students and the need to provide all students with more equitable classroom experiences.
### Average Scale Scores for Mathematics by Race/Ethnicity

<table>
<thead>
<tr>
<th>Year</th>
<th>4th Grade</th>
<th>8th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>234</td>
<td>203</td>
</tr>
<tr>
<td>2011</td>
<td>249</td>
<td>208</td>
</tr>
<tr>
<td>2000</td>
<td>224</td>
<td>224</td>
</tr>
<tr>
<td>2011</td>
<td>229</td>
<td>253</td>
</tr>
<tr>
<td>2011</td>
<td>244</td>
<td>270</td>
</tr>
</tbody>
</table>

- **White**: Blue bars
- **Black**: Red bars
- **Hispanic**: Green bars
Figure 12.1. Average high school credits earned by fall 2009 ninth-graders in STEM academic subject areas, by race/ethnicity: 2013

<table>
<thead>
<tr>
<th>Academic subject area</th>
<th>Number of credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>3.7, 3.6, 3.5</td>
</tr>
<tr>
<td></td>
<td>3.5, 3.4, 3.1</td>
</tr>
<tr>
<td>Science</td>
<td>3.9, 3.9, 3.3</td>
</tr>
<tr>
<td></td>
<td>0.5, 0.5, 0.5</td>
</tr>
<tr>
<td>Computer and</td>
<td>0.5, 0.5, 0.5</td>
</tr>
<tr>
<td>Information sciences</td>
<td>0.5, 0.5, 0.5</td>
</tr>
<tr>
<td>Engineering and</td>
<td>0.2, 0.1, 0.1</td>
</tr>
<tr>
<td>Technology</td>
<td>0.2, 0.1, 0.1</td>
</tr>
</tbody>
</table>

NOTE: Race categories exclude persons of Hispanic ethnicity. Estimates include ninth-graders who dropped out or did not obtain a high school credential by 2013. STEM refers to science, technology, engineering, and mathematics.


Figure 12.4. Percentage distribution of fall 2009 ninth-graders by highest mathematics course in which high school credit was earned, by race/ethnicity: 2013

Figure 13.2. Average high school credits earned by fall 2009 ninth-graders in Advanced Placement (AP) or International Baccalaureate (IB) courses for students who earned any AP/IB credits, by academic subject area and race/ethnicity: 2013

Trends – Teacher Preparation

Gender of Enrollees by Program Type*

- Female Enrollees:
  - Traditional IHE based: 77%
  - Alternative IHE based: 69%
  - Alternative not at IHEs: 66%
  - K-12 Students: 49%

- Male Enrollees:
  - Traditional IHE based: 23%
  - Alternative IHE based: 31%
  - Alternative not at IHEs: 34%
  - K-12 Students: 51%

*Source (K-12 data)
National Center for Education Statistics, Digest of Education Statistics

## Trends – Teacher Preparation

### Race/Ethnicity of Enrollees by Program Type*

<table>
<thead>
<tr>
<th>American Indian</th>
<th>Asian or Pacific Islander</th>
<th>Black</th>
<th>Hispanic</th>
<th>White</th>
<th>Multiracial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional IHE based</td>
<td>Alternative IHE based</td>
<td>Alternative not at IHEs</td>
<td>K-12 Students*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1%</td>
<td>1%</td>
<td>3%</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3%</td>
<td>4%</td>
<td>9%</td>
<td>11%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18%</td>
<td>11%</td>
<td>16%</td>
<td>11%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Source: U.S. Department of Education, Office of Postsecondary Education.  
Trends – Teacher Preparation

Trends in Enrollment Compared to K-12 Students

- **K-12 Student Enrollment**
- **Teacher Preparation Program Enrollment**

*Source (K-12 data)*
National Center for Education Statistics, Digest of Education Statistics

Source: U.S. Department of Education, Office of Postsecondary Education.
The field of mathematics education has acknowledged the role of culture in mathematical learning and how mathematics classroom cultures act as a context that support or constrain different forms of knowledge (Nasir, Hand, & Taylor, 2008).

Preparing teachers to build on students’ mathematical and cultural backgrounds is an opportunity for mathematics teacher educators (MTEs) to expose preservice teachers (PSTs) to the different ways students think about and learn mathematics.
The AMTE Standards for Preparing Teachers of Mathematics (2017) recommends that mathematics teacher educators, “provide opportunities for teacher candidates to learn about and build on the multiple mathematical, cultural, linguistic, and family strengths that students bring to the classroom.” (p. 35).
These culturally responsive strategies increase the likelihood of invoking students’ interests in mathematics and science while helping them develop a solid foundation in the field.

Several researchers suggest that teacher preparation programs are contexts to expose preservice teachers (PSTs) to these strategies and to develop their awareness of the types of instruction that can support or hinder students’ learning (Turner et al., 2012; Fernandes, 2012; Johnson & Atwater, 2014; Moore, 2011; Parsons, 2000).
CULTURAL AWARENESS IN MATHEMATICS PROJECT CAM UP!
What is culture?

- The consistent ways in which people experience, interpret, and respond to the world around them; It represents the “ways of being” of a collective population
- Culture is a feature of all human groups and is shaped by historical, social, political, economic, and even geographical factors
- Additionally, culture can be reinforced through contacts with social institutions such as places of worship and schools.

(Marshall, 2002, p.8)
A few common features of culture...

- Culture is learned, therefore it is adaptable and vulnerable to changes.
- Substantive cultural changes rarely occur quickly or easily.
- Through conscious (and sub-conscious) resistance, people tend to defend and protect their culture.
- Our own cultural ways of being tend to strike us as ordinary, usual, and normal. Consequently, we are often oblivious to the peculiarities of our own culture.
- It is not uncommon for other people’s cultural ways of being to strike us as quaint, strange, or even pathological.

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Cultural Awareness Unit

The unit has the following three goals:

1. develop PSTs’ awareness of the role of culture in the teaching and learning of mathematics,

2. develop PSTs’ awareness of stereotypes about who can do mathematics, and

3. help PSTs become aware of strategies to teach mathematics to all students.
Cultural Awareness Unit

The unit has the following three components:

1. **Article critique** - PSTs’ search for, read, and write a critique on an article that addressed the teaching or learning of mathematics to students who are culturally different from them.

2. **Class discussion** - PSTs share their critiques, define and discuss their own cultures and the different mathematics classroom, reflect on equity and access to mathematics, and examine stereotypes in mathematics education about who can do mathematics.

3. **Reflection** - PSTs reflect in writing on the unit and discuss how the activities influenced their views about the role of culture, teaching, and learning mathematics. become aware of strategies to teach mathematics to all students.
Cultural Awareness in Mathematics Project
CAM Up!

Based on the cultural awareness unit (White et al., 2016), CAM Up! was conceptualized.

The project is designed to examine the:
• replication of the unit in various mathematics methods courses
• replication of the unit in other content methods courses
• impact of the unit on PSTs ability to teach in culturally responsive ways
CAM Up!

Cross-Site study to prepare PSTs to work in culturally and linguistically diverse students by implementing the cultural awareness unit in mathematics methods courses at three (3) universities:
1. University of Georgia (PWI)
2. Morgan State University (HBCU)
3. Texas State University (HSI)
Cultural Awareness in Mathematics Project
CAM Up!

There are four components to the unit:
1. Article critique
2. Class discussion
3. Reflection
4. Mathematics Autobiography - PSTs reflect on your own experiences with mathematics as a student, in life, and how those experiences impact their attitude towards mathematics as well as your understanding of mathematics. They also reflect on whether teachers connected mathematics to your home/cultural/community experiences and the demographics of their schools.

1. Were most students in your math classes of the same ethnicity, race, gender, or linguistic or socioeconomic background as you? Did this change over time? If so, how?
CULTURAL COLLISIONS
PRELIMINARY FINDINGS
PRELIMINARY FINDINGS
PSTs’ Views on Cultural Differences

◦ Culture as race
◦ Culture as nationality
◦ Culture as socioeconomic status
◦ Culture as language acquisition

Many of the PSTs views reflect the dominant narratives of culture in the contemporary U.S.
One Potential Collision in Mathematics Classrooms

PSTs view students’ home language from a deficit perspective rather than a resource.

- Language is a resource for thinking, is linked to identity and a mathematical thinking identity and fluency, and is an explicit way to challenge the isolation of the learning of mathematics as something impersonal and irrelevant. (p. 4)

- [I]n equity-based mathematics teaching practices, especially in a context with multilingual students, the valuing of other languages, such as Spanish, is crucial for the inclusion of students’ lives, experiences, culture, and knowledge. Deeming one’s family language as an obscenity or as an area of self that needs to be silenced, hidden, or erased undermines the human right that we all have to embrace and appreciate our own identity. (p. 15)

LópezLeiva, Vomvoridi-Ivanovic & Willey (2019)
One Potential Collision in Mathematics Classrooms

- PSTs view students’ home language from a deficit perspective rather than a resource.
- English is my first language and I have a little background with Spanish. I personally have never had to deal with a teacher teaching in a language different from the one used at home.
- Coming from a white, middle-class, Christian home, my own cultural is generally the one most supported in U.S. public schools (at least in the South). Never having been a student in a classroom where my culture was not the norm, it is hard for me to imagine the way that students who get the adverse experience learn differently.
One Potential Collision in Mathematics Classrooms

- “English Language Learners (ELL) and African American English (AAE) speakers are groups who suffer greatly from culturally skewed word problems . . . [M]y family always spoke Standard English. Therefore, I never faced the barrier of making sense of the Standard Academic English that is used in schools.” ~ Student A

- Usually when people think of ELL students struggling with learning, it’s usually in reading and writing, where the students don’t know how to comprehend the words that they see on the page. Or they can’t write because they don’t know the English language well enough to write full sentences. In math though they don’t understand the language at all, putting them way behind because half the time they don’t understand the words that are being used in the problems, and thus can’t comprehend the problem at all. ~ Student B

Their culture is also different from ours by their country of origin and the amount of previous schooling. As a Latino, you could have grown up in so many different places around the world which can drastically change the child’s upbringing. Depending where the child grew up truly has a huge impact on the quality of education or amount of time that they go to school. This is different from our culture because English comes natural to us. Because we have an easier time reading, for most of us mathematics comes easier to us. It is easier for us to see mathematics around us in examples such as cooking, construction, shopping, and doing laundry. ~ Student C
QUESTIONS AND WONDERINGS
What are some ideas we should be thinking about?

What experiences do you have with preparing teachers for culturally and linguistically diverse students over sustained periods of time?

What frameworks guide your work?
Encouraged by...

- Math is culturally biased. It benefits students who speak the dominant language in the classroom, and often leaves students of other cultural backgrounds to struggle. As educators, it is our responsibility to create a space where all students feel valued in the subject – not just strong English speakers. Teaching math is so much more than just numbers – it is teaching a language that has the opportunity to be universal, as long as every student is considered and genuinely included throughout the process. ~A52
In closing..

◦ We want PSTs to realize that the classroom cultures they create are co-constructed with their students and families, with mathematics curriculum, and they own ways of being enculturated into mathematics education.
◦ We want PSTs to avoid collisions and to see their interactions with students as dynamic opportunities for learning.
In closing...

- Mathematics Teacher Educators must help PSTs acknowledge and challenge these views while they are in teacher preparation programs.
- Only then will we develop PSTs’ cultural consciousness, enabling them to build safe cultural spaces for students to learn mathematics.
“For I’m convinced that the pandemic we’re currently living through is both a manifestation of and a mere interruption in the relentless march toward an interconnected world, one in which peoples and cultures can’t help but collide.

In that world...we will learn to live together, cooperate with one another, and recognize the dignity of others, or we will perish.”

~ Barack Obama, 2020, p. xvi
¡GRACIAS!
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References


