Transnational and Borderland Research: Sonora–Arizona

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How did the project started:

University of Arizona-University of New Mexico
Cross-site collaboration
Research Objective

- To gain an understanding of the educational environments from which many Latino Students come (borderland communities in Sonora-Arizona), in particular in terms of their mathematics education.
Most immigrant students in AZ come from Sonora, MX, & most in NM come from Chihuahua, MX.

Our research (in AZ and NM) with immigrant parents (and with some students) brings up the issue of a more advanced mathematics education in Mexico (“The schools are very basic, the level in México is much higher.” [Mexican father])

Need to gain a better understanding of these perceptions

Our students are often caught between two worlds (Civil & Andrade, 2002; Suarez-Orozco & Suarez-Orozco, 2001)

Need for teachers to have a better understanding of their students’ backgrounds and experiences.
Visit to an elementary school in Agua Prieta, Sonora, MX

Participants

- Researchers
  - University of New Mexico
  - Richard Kitchen and Guadalupe Terán
  - University of Arizona
  - Marta Civil, Javier Díez-Palomar, Cynthia Anhalt, and Jesús Acosta-Iriqui

- School Participants
  - School Principal, 7 teachers, 59 students and 1 mother
Context

- Agua Prieta, Sonora, Mexico.
- Population: 70,303
  (INEGI Censo General de Población y Vivienda, 2005)
- Official Schools in Basic Education 2000-2001

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<th>Pre-School (Pre-escolar)</th>
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<th>Middle (Secundaria)</th>
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(Secretaria de Educación y Cultura)
School Context

- Participating school in the program “Escuelas de Calidad” (Schools of Quality)
- 430 students served approximately
- School serves students from different neighborhoods in the city
- School located two blocks from the international border
Important Characteristics of the AP Context

- Teachers’ practices promote the establishment of a complex “formal network” of pre-conceived solutions paths/strategies that students become quite adept at navigating.

- Teachers’ elicitation of creative student thought takes place only at the onset of a new topic's discussion, when notions are still quite simple (e.g., how to pictorially represent proper fractions,) and therefore…

- Meaning-giving representations/discussions (of a given topic, fractions in the lesson being addressed here) tend to primarily occur at the onset of a lesson.

- Meaning-giving representations/discussions diminish progressively as creative/inquiry-based understanding becomes constrained by the need to follow teachers’ pre-established “formal knowledge networks.”
Important Characteristics of the AP Context

- The school's staff, its administration, and even its students display a calm and positive determination to make a difference (both concerning curricular and extra-curricular activities.)
- Students and teachers exhibit a positive attitude towards knowledge acquisition, and at least an implicit confidence in their learning/teaching capabilities.
- Students show genuine respect for classroom time and educators: classroom dynamics are marked by cheerful politeness and orderliness.
- Educators implicitly encourage and acknowledge these practices.
- Both students and teachers appear genuinely invested in education and, at least implicitly, seek and embrace the idea of self-ownership of knowledge.
Methods

- Pre-visit - to provide a general idea for the principal and teachers participating of CEMELA’s work and our interest in working with them
- Two more visits (three visits total)
  - **First Visit:**
    - Classroom videotaped observations in grades 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th}, 5\textsuperscript{th}, and 6\textsuperscript{th} using the *Mathematics Classroom Observation Protocol*
    - Teacher interviews
    - Student interviews
    - 1 Parent interview
  - **Second Visit:**
    - Classroom observations in grades 3\textsuperscript{rd}, 4\textsuperscript{th}, 5\textsuperscript{th}, and 6\textsuperscript{th} taking field notes

- All interviews were audio-taped
Findings

Themes that emerged from the data analysis:

- **Student aspirations**
  - students talked about their futures and high expectations for themselves with respect to careers

- **Level of mathematics in the U.S. & MX**
  - students and teachers discussed their perceptions

- **Teaching with understanding**
  - Teaching operations conceptually in a context

- **Students sharing their thinking process**
  - Students show their work and explain their thinking
5th grade students talked about their futures and high expectations for themselves with respect to careers.

Yesenia: Pues yo hasta ahorita lo que he tomado de decisión es ser diseñadora de interiores.

Marta: Ahh diseñadora de interiores, o sea que esto te debe gustar mucho, no?, esto de hacer dibujitos a escala y todo eso no? Es una buena práctica,… y tú qué crees que vas a estudiar?.. perdón yo tengo (inaudible)…

Claudia: no se, yo tengo pensado ser doctora, abogada o si no administradora de empresas.

Marta: bueno, varias opciones, varias opciones, y tu que quieres estudiar.

Ariadna: Ingeniería industrial...

Marta: Hermosillo, y tú que vas a estudiar.

Francisca: Nada que ver con matemática, pediatra.

Marta: Pediatra, bueno pero también necesitan las matemáticas para llegar a la escuela de medicina supongo no?
Level of mathematics in the U.S. & MX

- Students’ perceptions of the level of the mathematics in the elementary curriculum in MX as compared to curriculum in the U.S. (AZ)

**Niña1:** A mí se me hizo muy diferente a como las matemáticas de aquí de México

**Marta:** ¿Ah sí? ¿Cómo se te hicieron diferentes?

**Niño:** Aquí están más difíciles que allá.

**Niña1:** Uhm, en veces difíciles, en veces fáciles. Porque uh por ejemplo a mi prima que es un grado mayor que yo, le ponían cuentas que yo ya sabía hacer desde primero

**Niña2:** están bien fáciles

[refers to what she sees with her cousins in Tucson]
A teacher’s perception of the level of the mathematics in the elementary curriculum in MX as compared to curriculum in the U.S. (AZ)

[5th grade teacher responding to a question on difference in level with children who come from the U.S.]

Maestra-Un grado más abajo...., o sea venían con boleta de cuarto, por ejemplo y nosotros lo ubicábamos en tercero. Ahorita ya no porque por legalmente traen documento oficial no.

Entonces ahora sí los dejamos en el grado que corresponde. Pero a los niños se les dificulta mucho las matemáticas por el grado que traen de allá.

Y antes cuando los bajábamos un grado, pues se les hacia un poquito más sencillo
Students show their work and explain their thinking

Lesson: multiplication of fractions (4th grade)

○ Students were copying problems from the board, drawing pictures, & solving the problems

○ A female student came up to the board to show her work on \( \frac{2}{4} \times 5 \)

\[
\frac{2}{4} \times 5 = \frac{10}{4}, \text{ así que son 2 y } \frac{2}{4}
\]

“Son 10/4, así que son 2 y 2/4” (It’s 10/4, so it is 2 and 2/4)
G. Terán’s Proposed Study: Goals & Motivation

To use one or more multi-part, conceptually integrated activities to assess experienced, Latino (Mexican), in-service, middle-school teachers

1. acquaintance with,
2. disposition towards, and
3. in-classroom use of,
   meaning-giving pictorial and verbal representations of the “invert and multiply” rule traditionally used to divide fractions.

My interest in seeking to understand why Latino teachers/students who exhibit:

- relatively deep formal knowledge of fractions (as defined within)
- above-the-norm dispositions toward teaching/learning,

may also tend to also exhibit:

- shallow levels of mathematical analysis in the classroom.
Other Noteworthy Study Characteristics…

(a) The proposed focus on teacher's “embodied and enacted understanding” (as defined by Davis, et.al., 2006) of the mathematics of division of fractions;

(b) The emphasis on interpretative meaning-seeking techniques that stem from a participant's analysis of a third-party (eg: student) non-conventional solution to division of fractions problems.
A Classroom Vignette: El Salón de Sylvia

• Sylvia’s classroom atmosphere on Day 1 of the observation is one of multi-party support among the student audience, the student presenter, and the teacher.

• Pedro’s presentation gives rise to a discussion that could have set the stage for a series of meaning-giving pictorial representations of fraction operations, beyond doubling and tripling simple proper fractions. However…

• As soon as addition and subtraction of fractions enters the discussion, all pictorial representations of solutions and solution processes leave it.

• A gradual, downward shift in the level of mathematical analysis framing the classroom discussion, begins to emerge yet it is masked by..

• The success of the students at solving progressively difficult traditional problems which are often perceived as indicators of deep mathematical knowledge*. (Eg: flawless performance of long division calculations yielding either truncated decimals with very long decimal tails or repeating decimals with long repeatends.)

• Similar dynamics were observed even more markedly* on Day 2 of the observation. (See full written proposal.)
1. Most published work focuses on students' conceptual understanding of fractions and division (generally of integers) (e.g., Clarke and Sukenik, 2006; Weinberg, 2001; Goldin and Passantino, 1996), rather than on experienced teachers' “embodied and enacted understandings” around such topics (Davis, et. al., 2006).

2. Most published work on fractions is primarily concerned with the intrinsic meaning of fractions themselves (e.g., Clarke and Sukenik, 2006; Weinberg, 2001; Goldin and Passantino, 1996), and hence does not address meaning-seeking approaches for understanding fraction operations.

3. Data for investigating people's meaning-seeking approaches seems to only include a participant's own approach to solving such problems rather than also participants' interpretations of non-conventional third party solutions.

4. Most research that centers on conceptual understanding of fractions and number operations ultimately focuses on trying to discern what students know/do not know (Weinberg, 2001), and on and making recommendations that may affect standardized tests performance, content, pedagogy (Clarke and Sukenik, 2006) or teacher's professional development (Goldin and Passantino, 1996). My motivation is different: this study seeks to ultimately inform the apparent unbalance between levels of mathematical analysis and depth of knowledge observed in the study’s setting.

(*) This is a very minimal summary--see full written proposal for more. GIT, Jan 08, S6
Ms. Irene is selling home-made galletas ("galletas caseras") as part of the "Día de los Muertos" festivities. It is late in the day and all that it is left is $\frac{7}{10}$ of a box of Ms. Irene's galletas. Three friends are considering splitting Ms. Irene's remaining galletas among themselves.

Rita, one of the three friends, wants to bring home at least a quarter of the whole box of galletas. Mario reassures her saying:

"Don't worry Rita. Three-quarters of the whole box of galletas is less than 70% of the whole box, so you will for sure have a quarter of the whole box to take home, or maybe more."

Make sense of Mario's reasoning and decide whether or not his conclusion is correct. If his conclusion is not correct, fix Mario's argument to show whether or not Rita will end up with as much of the box of galletas as she wants.
Problem (c), Item (i).

Ms. Irene wants to bake at least 5 more boxes of galletas to sell during the second day of festivities. Each box of galletas takes $\frac{3}{4}$ cups of flour. As she leaves home to buy the flour, Ms. Irene reasons as follows:

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Three and three is six. So one-and-a-half makes two, and three makes four, which means four cups should surely be enough for five batches. I will buy 4 cups of flour.
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Make sense of Ms. Irene's reasoning and explain why her argument works.

Problem (c), Item (ii).

At the corner store they only sell flour in 5-cup packs. Ms. Irene goes ahead and buys one of these packs. Exactly how many boxes of galletas can Ms. Irene bake with the 5-cup pack? Explain your thinking using pictures.
Proposed Tasks: Further Comments

1. The *first item* in each of the previous problem set requires interpreting someone else's reasoning, while evaluating the validity of this reasoning as an actual solution strategy to the original problem. This is the type of question this study seeks to focus on.

2. The second item asks simply for a participant's own picture-based solution; the third problem entails representing the problem (not necessarily solving it) symbolically.

3. Problems sets are embedded in a 5-part (a)-(e) integrated activity of increasing conceptual complexity.

4. Problem (d) turns the spotlight directly upon *meaning-giving pictorial representations of the ``invert and multiply'' algorithm*, and Problem (e) closes the activity with a division problem involving mixed numbers.

5. Teachers’ inquiry-based work on each problem set will be followed by teacher lead open-discussion sessions stemming exclusive from teachers’ work and other teacher-generated ideas.
Proposal Summary

• This study seeks to present experienced, _in-service Mexican teachers_ in a _Mexican borderline school_ with a series of integrated scenarios in which a third-party (eg: student) solves _division of fractions problems using highly non-formal, meaning-seeking arguments_.

• Analyzing how acquainted teachers are with and respond to such problems may help one understand and explain the predominant ``formal networks'' dynamics observed within their classrooms.

• It may also potentially enrich classroom practices through teachers' awareness of the nature of meaning-giving representations of relatively complex problems (eg: division of fractions.) This is not a direct goal of the proposed study, however.

• Noteworthy additional points are detailed in the _Goal and Motivation Slide_, at the beginning of the series, and in the _extended written version of this proposal_.

GIT, Jan 08, S10
We are currently planning several more trips and observations to Agua Prieta Son, MX elementary schools (escuelas primarias) near the international border to continue collecting data.

We will possibly focus our work on the upper elementary grades (5th and 6th) at least in two schools, the one we had already visited and a second one that does not participate in the program “Escuelas de Calidad”
References


