



Mathematical Equity for Immigrant Students through Formative Assessment

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educación



Non-Latino teachers' characteristic lack of knowledge of the Spanish language and dismissive attitude toward Mexican culture makes them unlikely to be familiar with the cultural definition of *educación*. Thus, when teachers deny their [Latino/a] students the opportunity to engage in reciprocal relationships, they simultaneously invalidate the definition of education that most of these young people embrace. And, since that definition is thoroughly grounded in Mexican culture, its rejection constitutes a dismissal of their culture as well.

(Valenzuela, 1999, p. 23)

low expectations for ELLs



- For years, researchers have documented how low academic expectations are often the norm for racial/ethnic minorities such as ELLs and students living in poverty (e.g., Ferguson, 1998; Grant, 1989; Zeichner, 1996).
- Latino/a students often attend crowded schools in poor neighborhoods and those schools often do not have adequate resources to attend to students' needs (Borjian, 2008; Fry, 2005; Lockwood & Secada, 1999).
- Knapp and Woolverton (1995) claimed that controlled forms of instruction teach students living in poverty that little is expected from them except compliance to a rigid classroom environment.
- Similarly, studies have documented how educators of Latino/a students often make the memorization of math facts, algorithms, vocabulary and procedures the focal point of their instruction, rather than teaching students using complex, challenging problems (Flores, 2007; Moschkovich, 2007).

additional challenges for ELLs



- ELLs often enter U.S. schools performing below their English speaking peers and their academic progress usually is measured with inadequate tools that do not accurately represent their learning (Abedi & Gándara, 2006; Abedi & Lord, 2001).
- Instead of viewing the language resources that immigrant Latino/a youth bring as “Spanish dominant” or as potential bilinguals, they are generally pigeonholed as “limited English proficient” (Valenzuela, 1999).
- When immigrant Latino/a students speak with an accent, use English words incorrectly or speak in Spanish as a means to express themselves, educators, peers and community members may assume they lack the capacity to perform well in mathematics (Gutiérrez, 2007; Moll & Ruiz, 2002; Moschkovich, 2007).

deficit perspectives



- “Deficit perspectives” attribute lower levels of academic achievement to specific ethnic/racial groups based upon characteristics such as lack of fluency in English, life experiences that do not parallel those of the dominant society, or low family income (Khisty, 1995; Lubienski, 2007).
- Instead of looking at students and their communities through a deficit lens, they can be viewed as having funds of knowledge such as knowing one language and learning another, having experiences that are richly grounded in their culture, and having extensive mathematics experiences in their daily lives (Moll & Ruiz, 2002).
- If educators build on the attributes students possess and treat them as mathematically competent, there is greater potential for increased academic success and an enhanced mathematical identity (Empson, 2003; Turner, Celedón-Pattichis, & Marshall, 2008).

challenging deficit perspectives



- To counteract deficit views of ELLs, researchers have documented how their prior knowledge, language and culture must be integrated into instruction and assessment tasks (Abedi & Gándara, 2006; Lockwood & Secada, 1999).
- ELL students benefit from the use of their home language and other feedback techniques; they benefit from the translation and explanation of key words and sentences, by reflecting on their own thinking, assessing their own errors and having teachers and peers revoice their explanations (Abedi & Gándara, 2006; Borjian, 2008; Lockwood & Secada, 1999).
- Instruction for ELLs should be supportive of students using resources such as gestures, concrete objects such as drawings, and the use of their first language to communicate their mathematical thinking (Moschkovich, 2002).

introduction to study



- In the study reported here, immigrant Mexican students often used gestures and mathematical representations to explain complex mathematical ideas.
- Commencing in spring 2008, we began conducting intensive one-on-one interviews with four bilingual immigrant Mexican students to document the progression of their mathematical thinking through a series of rational number tasks.
- Using a formative assessment format that we refer to as the “interactive interview protocol,” two interviewers created a learning environment in which the four participating students had multiple opportunities to solve and then refine their solutions to the tasks.

research question



In what ways can an interactive interview assessment protocol as a formative assessment tool support the demonstration of mathematical knowledge of sixth-grade, ELL students?

intro. to alternative assessment



- For almost two decades, researchers and policy makers have been advocating for revisions in assessment practices to bring about changes in instruction based on how children learn (e.g., Kulm, 1994; O'Day & Smith, 1993).
- The dominant 20th-century paradigm included social efficiency theory (e.g., managing schools like factories), behaviorism (learning as the accumulation of bits of knowledge), and scientific measurement (e.g., objective tests to measure achievement). In this paradigm, assessment is viewed as an official event, separate from instruction.
- Often coined as “alternative assessment formats,” new approaches to assessment promote higher order thinking among students, elicit a range of student responses, and require students to communicate their thinking (Wiggins, 1993).
- Alternative assessments formats align with mathematic education reforms (National Council of Teachers of Mathematics, 1989, 1995, 2000; National Science Foundation, 1996) in which the primary goal is for students to develop mathematical understanding by making connections, communicating, representing, and problem solving (Hiebert & Carpenter, 1992; Hiebert, Carpenter, Fennema, Fuson, Human, Murray, Olivier, & Wearne, 1996).

classroom assessment



- There are two categories of classroom assessments; summative and formative.
- Summative assessment formats focus on what students know at a given time (Guskey and Bailey, 2001).
- Formative assessments differ from summative assessment in that the focus is not just on summarizing students' learning, but on using student learning data to inform instruction.
- After examining 250 research studies on classroom assessments, Black and Wiliam (2001) found that when teachers focus on formative assessment, student achievement gains are among the largest ever reported for educational interventions.
- Formative assessments at the level of the classroom can include any of the following: classroom observation, inquiry, group work, whole class discussions, peer assessment, written work, individual interviews, student self-assessment, and portfolio assessment (Gearhart & Saxe, 2004; Stiggins, 2001).

our belief



- A fundamental belief of our research team was that promoting classroom-level assessment practices that dynamically validate students' ideas and thinking is a social justice issue, particularly for ELL students who have historically been marginalized in the mathematics classroom.

theoretical frame



- Theoretical framework draws upon two areas:
 - (a) the notion of “teaching for diversity,” and
 - (b) social-constructivism.

First goal: Infuse notions of equity and justice into well-established theoretical frameworks.

Second goal: Push theoretical constructs that may not necessarily challenge taken-for-granted educational structures and practices that may be detrimental to ELL students.

teaching for diversity



- For progressive educators, a potential role of the mathematics education reform movement is to promote more egalitarian and democratic societies in which *all* students, not just a select few, have the opportunity to develop mathematical literacy (Kitchen, 2005).
- While much has been written about the need to implement standards-based curriculum and instruction in mathematics classrooms, little emphasis has been placed on preparing teachers of mathematics to implicitly and explicitly incorporate socially, culturally, and politically equitable instructional strategies in their classrooms, that is, “teach for diversity” (Rodriguez & Kitchen, 2005).
- Ultimately, teaching for diversity entails teachers of mathematics teaching in more culturally responsive, gender-inclusive, and socially relevant ways (Rodriguez & Kitchen, 2005).

teaching for diversity2



- There is a developing body of inquiry into the social, cultural, and political context of the teaching and learning of mathematics (see Atweh, Forgasz, & Nebres, 2001; Gutstein, 2003; Kitchen, 2005; Martin, 2000; Secada, 1995).
- Research and teaching in mathematics education that takes seriously the social, cultural, and political context of learning examines how tracking affects learning, whether diverse students have equitable opportunities to learn challenging mathematics, and how race and class play out in the classroom.

significance of critical studies



- The significance of these studies is that they redefine traditional notions of “effective pedagogy” (Roy & Kitchen, 2005).
- Effective teaching is viewed as more than engaging students in constructivist-based mathematics activities.
- Specifically, teaching for diversity promotes the development of students’ cultural identity, empowerment, and social justice.
- These ideals are beyond that of the equity vision put forth in the Principles and Standards for School Mathematics [PSSM] document (NCTM, 2000), which largely supports learning dominant, albeit reform-based, mathematics (Gutiérrez, 2002; Rodriguez & Kitchen, 2005) with little attention given to issues of culture and social criticism.

social-constructivism



- The emergent social-constructivist paradigm borrows from cognitive, constructivist, and sociocultural theories (Shepard, 2000).
- Within the cognitive psychology paradigm, scholars seek to understand an individual's learning in term of internal cognitive structures and processes (Cobb, 2007).
- For a constructivist, the learning of mathematics is viewed as an active process of mental construction and sense making.

social-constructivism2



- In the sociocultural perspective, learning is developed through socially supported interactions.
- From this perspective, cognition is inherently social and learning is viewed as an element of a system of cultural practices (Vygotsky, 1979; Cobb, 2007).
- Vygotsky advocated that we not only look at mental activity but at situated practices and that the process must be studied, not just the outcome of activities (Forman, 2003).
- Thus, sociocultural theory provides a means to explain the complex relationship between social context and learning.

social-constructivism reconsidered



- A shortcoming of Vygotsky's work is the lack of analysis of how individual agency can transform these contexts (Rodriguez, 2005).
- As students participate in mathematical learning communities, they build on their previous experiences and knowledge to achieve a more advanced understanding of challenging mathematical concepts.
- They may also begin to ask critical questions such as: "Why should I bother to solve this problem? For whom am I solving this problem? Whose mathematics is this, anyway?"
- Students are not simply participants in pre-existing cultural practices, they are also active participants in transforming systems of cultural practices.

merging teaching for diversity with social-constructivism



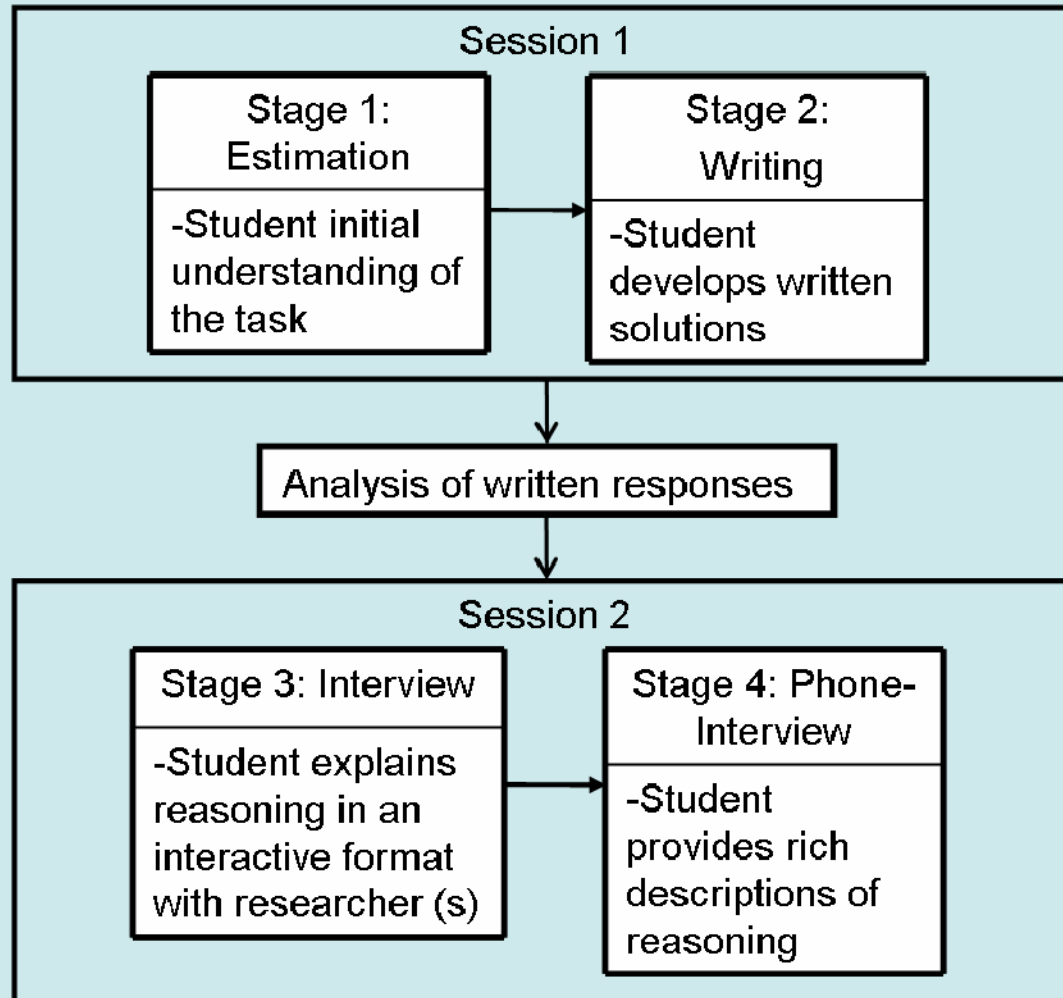
- In the social-constructivist paradigm, classroom expectations and social norms are examined to understand how important dispositions, such as students' willingness to persist in trying to solve difficult problems are developed (Shepard, 2000).
- Teaching for diversity problematizes general references to students and considers how race, ethnicity, gender, social economic status, etc. may affect opportunities students have and how this impacts the development of student disposition.
- Teaching for diversity brings issues of cultural and linguistic diversity and equity to the forefront in all considerations having to do with classroom learning, and also with the very structures of schools and schooling.
- Overlaying teaching for diversity with social-constructivism inspires both a commitment to equitable and just educational opportunities for all learners in which each student's ways of thinking is honored.

research methodology



- Last spring, a research protocol was designed that included a progression of clinical interviews that were conducted with four students.
- The protocol has four stages:
 - (1) Students are asked to estimate solutions to a series of mathematical tasks;
 - (2) Students complete the tasks in writing while working alone;
 - (3) Follow-up interviews are conducted with each of the four students in which students initially explained their task solutions; and then
 - (4) Students are asked in a telephone-simulation interview to explain their solutions to someone who did not have access to the tasks.
- For all four stages, students can speak/write in Spanish or English. Students are videotaped during stages 1, 3, and 4.
- All the tasks are based on problems from the Bits & Pieces I, II and III units in the CMP and are specifically selected because of their focus on fractions, decimals, and proportional reasoning.

The Interactive Interview Protocol



math task & questions



- Zenia:

$39 \frac{1}{6} - 28 \frac{5}{9}$

Video: What does she understand well?

Written Work: If she was just judged for her performance on a written test, how would she have done?

written response



2. b Ariel drove his bike $39\frac{1}{6}$ meters and Nick drove his bike $28\frac{5}{9}$ meters. How many more meters did Ariel drive than Nick?

$$39\frac{1}{6} = \frac{235}{6} \times \frac{9}{9} = \frac{2106}{54}$$

$$28\frac{5}{9} = \frac{252}{9} \times \frac{6}{6} = \frac{1512}{54}$$

$$\begin{array}{r} + 28 \\ \frac{23}{9} \\ \hline \frac{37}{9} \end{array}$$

$$\begin{array}{r} + 28 \\ \frac{252}{9} \\ \hline 1512 \end{array}$$

$$28\frac{5}{9} = \frac{257}{9} \times \frac{6}{6} = \frac{1542}{54}$$

$$\frac{594}{54} = 11$$

$$\frac{235}{6} \times \frac{9}{9} = \frac{2115}{54}$$

1

research findings



- The interactive interview protocol provided the means for an in-depth understanding of participating bilingual immigrant Mexican students' mathematical knowledge, reasoning and procedural ability.
- Throughout, it was not unusual for students to develop and connect mathematical ideas as they solved problems.
- Students not only spoke in English and Spanish to express their thinking, but also communicated their ideas non-verbally, using gestures, diagrams, and mathematical representations.
- In general, students explored mathematical concepts deeply without fear of reprisals when they made errors.

research findings2



- Similar to other studies that examined whether summative assessments in mathematics disadvantage students who are learning English as a second language, (Abedi & Lord, 2001; Lampert & Cobb, 2003; Morgan & Watson, 2002), we found that participating students' written responses gave a very limited snapshot of their mathematical reasoning and communication.
- Our understanding of the participating students' mathematical knowledge is far greater than what we could have obtained solely through traditional means.
- In contrast to large scale, high stakes tests that only afford insight on specific tasks on which a student fails, a formative assessment tool such as the research protocol provides the means for in-depth individual diagnosis (Noddings, 2004).
- The interactive interview protocol proved quite effective at uncovering the four participating students' mathematical reasoning and inspired multiple opportunities for the researchers to engage in mathematical discourse with students, encourage students, provide scaffolding when students struggled to connect ideas, and to teach mathematical ideas that students could use to problem solve.

looking back



- In the introductory excerpt, Valenzuela calls out teachers who “deny their [Latino/a] students the opportunity to engage in reciprocal relationships” (1999, p. 23) as repressing their Latino/a students as cultural beings.
- In this study, we learned of the potential of the interactive interview protocol to support the development of trusting and affirming relationships which ultimately led to mathematically inspiring Latino/a youth.
- Through the fruition of these positive relations, the research protocol provided a means to position students as competent problem solvers (Empson, 2002; Forman, 2003; Turner, Celedón-Pattichis, Marshall, 2008) and to support bilingual learners using the resources that they bring to the learning process (Moschkovich, 2002).
- Because of the interactive interview protocol’s usefulness, we argue that this alternative assessment format has great potential for use in classrooms that serve majority Latino/a populations.

looking back2



- In retrospect, the research protocol served as a means to cultivate a culturally affirming and empowering learning environment for the participating bilingual immigrant Mexican students.
- The social-constructivist framework provided us with the means to analyze students' thinking, while continually reminding us of the constraints of summative assessment formats such as traditional pencil/paper tests.
- After reflecting upon our insights about students' learning (e.g., innovative, willing to take risks, etc.), a compelling image emerged of the participating students and of their mathematical competencies and potential.
- The result was a revelation of sorts of what is possible if formative assessment practices are coupled with attention to the cultures and social identities of Latino/a youth.

contact information



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