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# Moving Beyond Numbers: Examining Language in Mathematics Classrooms

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# Moving Beyond Numbers: Examining Language in Mathematics Classrooms

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## Introduction

There is growing attention on the mathematics learning experiences of emergent bilingual students, a term used rather than English language learners to emphasize the rich linguistic knowledge of students who know and speak two or more languages instead of how they are often positioned of not knowing English, in the field of mathematics education. The majority of past and current studies have examined the impact of students' language proficiency on academic performance. While this work has deepened understanding of mathematics learning for emergent bilinguals, language is only one of many semiotic resources (e.g. physical control of space, gestures, and gaze) at play in bilingual/multilingual classrooms. Research is needed that unpack the development of principled instruction that supports students' engagement in meaningful disciplinary discourse practices.

Using Cultural Historical Activity Theory (CHAT) as a framework, classrooms are examined as complex activity systems. Specifically, we highlight a framework to analyze a mathematics classroom and bring to attention ways to honor and leverage students' funds of knowledge to develop language and mathematical understanding. Study findings demonstrate the importance of using a systems approach to examining individual and intersectional impact of teacher's decision-making (e.g. tasks, mediating artifacts, division of labor, community, and norms) on student learning. Findings offer guidance to mathematics educators on the design of classroom learning spaces that better leverage emergent bilingual students' individual and collective knowledge.

## Methods

This study uses an ethnographic case study to examine the teaching and learning experiences of a first-grade bilingual classroom.

**Participants**
The teacher attended a post-baccalaureate teacher education program at a West Coast public university. She was selected purposefully because of her expressed commitment to bilingual education and equity-oriented teaching. She now teaches at a dual language program (English and Spanish) in an urban elementary school named Valadez Elementary. By examining her teaching context, we are able to use this unique opportunity to examine her teaching practices within a mathematics classroom.

**Data**
Data was collected for three years with three visits per year. During the classroom visits, 50 to 70 minute mathematics lessons were video recorded along with a 30 to 60 minute post-lesson interview. Classroom artifacts (lesson plans, student assignment, and class generated work were gathered to serve as data sources.

## Theoretical Framework

Cultural Historical Activity Theory (CHAT) guides our examination of learning (Engestrom, 2001). We view learning as a social, historical, and cultural practice, and classrooms are complex activity systems (Engestrom, 2001). Learning is a social endeavor that occurs as students engage individually and collectively with each other and with mediational tools that shape their participation in the classroom activity system (Lave & Wenger, 1991). Language is a central tool that impacts student participation, and therefore, their learning.

## Findings

The teacher uses three central principles to support disciplinary literacy. Figure 1 provides a visual of how the teacher organizes a classroom activity system to honor and leverage students' fund of knowledge (Gonzalez, Moll, & Amanti, 2005) when developing their language and mathematics skills.

**Three central principles to support disciplinary literacy:**
1) honor students' linguistic, cultural, and experiential knowledge;
2) focus on a multi-modal approach
3) distribute knowledge authority in the classroom to ensure that ALL students have opportunities to demonstrate their "mathematical brilliance".

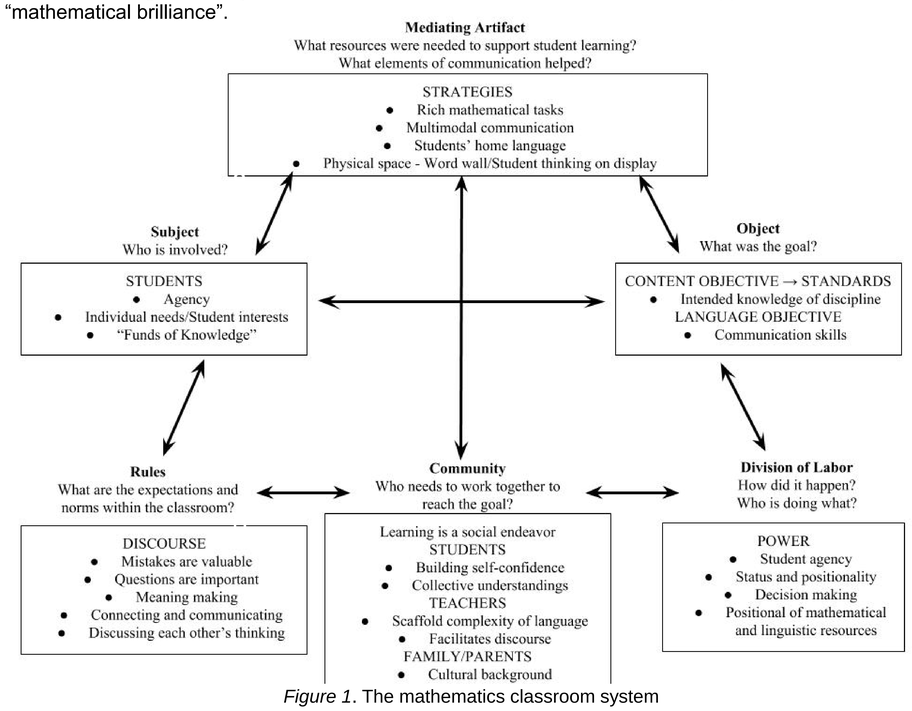


*Figure 1*. The mathematics classroom system

*Figure 2*. Classroom Layout 1

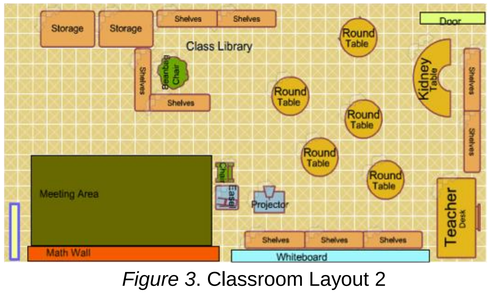


*Figure 3*. Classroom Layout 2

*Figure 4*. Meeting area

*Figure 5*. Mathematical tools and supplies

## Findings

| CHAT ELEMENT | ELEMENTS IN PRACTICE |
|---|---|
| **Meditating Tools/ Artifacts** (the tools available that mediate student participation) | •Design mathematics curriculum that build from cognitively demanding tasks that focus on mathematical understanding and reasoning and leverage students' experiential, linguistic, and mathematical knowledge<br>•Affirm students' home and everyday language, code switching, and interactional patterns familiar to students.<br>•Use and promote multimodal communication (verbal, written, physical materials, models, gestures,) to represent ideas<br>•Display student work/thinking |
| **Rules** ( expectations and norms within the classroom) | •Recognize student voice has implications for power and student agency<br>•Explicitly communicate high academic expectations for all students<br>•Expect students to solve problems on their own in ways that make sense to them<br>•Construct social structures that enable students from non-dominant backgrounds to serve as principle players in the classroom discussion.<br>•Develop norms for students to take risks, construct meaning, and to collectively seek reinterpretation of knowledge (Garcia & Gonzalez, 1995, p. 424) |
| **Community** (students, parents, teacher) | •Building students' self-confidence<br>•Acknowledge that learning is a social endeavor<br>•Distribute the knowledge authority across participants |
| **Division of Labor** (refers to the hierarchical power structures and the way in which labor is divided within the classroom system) | •Recognize that certain groups have been positioned with higher status than others<br>•Share power in the classroom by providing student agency in problem-solving, communication structure, and classroom decision-making<br>•Position students as mathematical and linguistic resources for each other |

## Implications

**From Research to Practice**
Every decision teachers makes impact student learning. Therefore, teachers need to view classrooms from a systems perspective in which each component (rules, community, artifacts, and division of labor) are interconnected. It is not just one component that supports students' learning and development of mathematics and language, but how its interconnection that matters.

**From Practice to Research**
Research often examine achievement using a single measure. A single measure does not capture its complexity. Future studies would benefit from the use of multiple measures to capture student achievement and teacher effectiveness.

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