

MULTILINGUAL CLASSROOMS: DEVELOPMENT OF AN OBSERVATIONAL ANALYTIC TOOL TO EXAMINE MATHEMATICS INSTRUCTION

AULAS MULTILINGÜES: DESARROLLO DE UNA HERRAMIENTA ANALÍTICA DE OBSERVACIÓN PARA EXAMINAR LA ENSEÑANZA DE LAS MATEMÁTICAS

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This brief research report describes the refinement and testing of an observational rubric designed to identify and assess elements of classroom mathematics instruction that research has found to support multilingual student learning. The aim of this process is to (a) combine existing rubrics that capture teaching strategies and positioning construct protocol, (b) test the combined rubric in multiple elementary classroom settings, (c) revise the rubric in light of testing to create a more consistent version, and (d) retest with a larger sample of classrooms. Initial results include revised instrument category rubrics and level descriptors, and the creation of a new conjectural code category.

Keywords: Social Justice; Instructional Activities and Practices; Equity, Inclusion, and Diversity; Elementary School Education

Introduction

Education inequities persist across the United States, significantly affecting multilingual students. Multilingual students are children learning the language(s) spoken at home in addition to English (García & Kleifgen, 2010). Many multilingual students attend schools with limited resources that are less well-equipped to support their specific learning needs in general (NASEM, 2017) or to draw on their cultural and linguistic resources in the ways necessary for an equitable mathematics education in particular (Nasir & Hand, 2006).

To support the improvement of learning opportunities for multilingual students, an interdisciplinary team of researchers across three universities in the Mid-Atlantic, Southwest, and Midwest United States received a collaborative National Science Foundation grant, “Together/Juntos,” to *develop and research an innovative mathematical partnership that engages teachers, parents, and multilingual students in elementary grades in underserved communities*. One of the main goals of this project focuses on improving the quality of mathematics instruction in linguistically diverse classrooms. To analyze progress towards this goal, we needed a classroom tool that would (a) measure “high-quality” mathematics instruction that is relevant for multilingual students, (b) validate student differences, and (c) be culturally responsive.

Purpose

The primary purpose of this study is to refine and test an observational tool that responds to the mathematics-instructional and positioning practices of teachers of multilingual students in

elementary grades. In this paper, we describe the adaptation process of the Quality of Linguistically Diverse Teaching (QLDT) protocol (Sorto et al., 2018) and the Equity and Access Rubrics for Mathematics Instruction (EAR-MI) (Wilson et al., 2019) to a more heterogeneous context with respect to languages present in the classroom and geographical region. Ultimately this adapted rubric will serve as a primary analytic tool answering broader research questions about the impact of professional development on teachers' quality of mathematics instruction for, and the classroom positionality of, multilingual students.

Theoretical framework

Elevating multilingual students' mathematics and linguistic knowledge requires teachers with asset-based dispositions and specific pedagogical skills. Chval and Chávez (2011) argue mathematics instruction for multilingual students requires teachers who support students' mathematics learning, develop students' language or languages, incorporate students' life experiences into instruction, and facilitate productive interactions. Aligned with these recommendations, Moschkovich (2002) suggests classroom instruction must be grounded in a situated and sociocultural perspective of mathematics learning that rejects a deficit view of multilingual students and focuses on the discourse embedded within and constituent of mathematics practices. While some aspects of classroom mathematical discourse, such as the use of mathematical vocabulary or multiple meanings of words, are easier to identify and assess, there is a need for tools that assess classroom mathematical discourse practices more broadly in a way that is tailored to multilingual students and that integrate attention to student identities and classroom positioning (Davies & Harré, 1999; Holland et al., 2001). Our approach to assessing quality mathematics instruction, and the tool we are developing, incorporates the above ideas to help researchers understand what successful teacher support of multilingual mathematics students looks and sounds like, and to characterize the sorts of interactions that take place in such an environment.

Methods

Phase 1: Initial Development

The development of the observational tool started with a review of existing observational rubrics from studies that investigate mathematics classroom interactions. These included (1) the Mathematical Quality of Instruction (MQI) tool (Hill, 2014), (2) the QLDT protocol, which augments the MQI with dimensions that focus on teaching moves or routines specifically tailored for linguistically diverse classrooms (Sorto & Bower, 2017; Sorto et al., 2018), and (3) the EAR-MI (Wilson et al., 2019; Wilson, 2022), which was designed to complement the Instructional Quality Assessment (IQA) rubrics (Boston, 2012). Sorto and colleagues (2018) developed the QLDT to leverage the elements of Chval and Chávez's (2011) research-based instructional practices to support multilingual students in mathematics. It contains six instructional strategy categories: "Connections of mathematics with students' life experiences," "Connections of mathematics with language," "Meaning and multiple meanings of words," "Use of visual aids or support," "Record of written essential ideas and concepts on board," and "Discussion of students' mathematical writing." Each category can be coded as "Not Present", "Low", "Mid", or "High." The EAR-MI is a set of rubrics that attends to practices observed in classrooms where there was evidence of conceptually oriented instruction and of more equitable access for students who are typically pushed to the margins (Wilson & Smith, 2022). Among the diverse practices that the EAR-MI highlights, we focused on one in particular: positioning students as competent

by framing students' actions and statements as intellectually valuable. The EAR-MI positioning rubric highlights moments when the teacher explicitly states that a student is capable of participating in rigorous mathematical activity and/or is making important contributions to the learning community. This positioning rubric was added to the QLDT at the onset of Phase 2.

Phase 2: Testing and Revising

During the Together/Juntos project's first year, 22 classroom lessons from nine teachers were videotaped at two school sites. The first site was a dual language P-8 school in a large city in the Southwest U.S. This school serves roughly 580 students, of whom 80% are eligible for free or reduced lunch and 92% are Latinx. Students at this school learn to read and write in both English and Spanish, although mathematics classes are primarily taught in English. All teachers observed are bilingual, as are the majority of the students. Five teachers were recorded teaching mathematics lessons in their classrooms: three fifth grade teachers, one third grade teacher, and one second grade teacher. The second site was a suburban K-5 elementary school in a diverse community outside of a large Mid-Atlantic city in the U.S. The school has roughly 550 students, of whom about half are eligible for free or reduced lunch. More than half of the students (56%) are Black, 19% are White, and 13% are Latinx. Students at this school receive classroom instruction in English. Four teachers were recorded teaching mathematics in their classrooms: two fourth grade teachers, one fifth grade teacher, and one third grade teacher. Half of these teachers speak and understand a little Spanish, the rest do not.

Three trained doctoral students ("the coders") coded 22 lessons following the QLDT protocol, which is modeled after the MQI. For every 7.5-minute video segment, each coder independently assigned a code (Not Present, 0; Low, 1; Mid, 2; or High, 3) to each QLDT instructional strategy element, as well as to the EAR-MI positioning element. After coding an entire lesson, coders would then compare and discuss their coding and arrive at consensus where necessary. After coding all 22 videos, coders compiled their notes and email exchanges to begin revising the instrument rubrics. The overarching goals during this revision process were to remove ambiguities remaining from Phase 1, improve clarity, and brighten the distinction between the different rubric categories and coding levels. For example, the original description of the "Use of visual aids or support" category did not foreground the idea of dynamism, although the QLDT creator highlighted this idea as central during initial instrument training sessions (see Table 1 below). Furthermore, the original description includes examples that could be considered static (e.g. "formula charts . . . times tables"), and the term "dynamic" itself is not defined nor does it appear in the category title.

Initial Results

We have revised all six QLDT rubric categories and further integrated the EAR-MI positioning rubric into a tool we currently call the QLDT+P. Table 1 presents an example of a revised code (level descriptors have been omitted for reasons of space). Overall, the revised codes offer more thorough and explicit guidance based on coders' experiences wrestling with applying the original descriptors to various classroom circumstances, including specific language to help deal consistently with recurring ambiguous cases and examples drawn from actual lessons to further illustrate and clarify this guidance. The revisions provide more direction as well regarding when a situation should be classed as Not Present, Low, Mid, or High in at least three ways: (1) by including more decision rules for when something should be classed as one level or the other, (2) by providing extended examples within the descriptors of when something would count as one level or another, and (3) by overhauling ambiguous terminology.

Table 1: Use of dynamic visual aids or support

Original description	Revised description
For example, concrete objects or manipulatives, videos, and illustrations in classroom conversations. Concrete objects may include times tables, formula charts, protractors, 2D models, or dynamic foldables.	The lesson or activity uses dynamic aids that support mathematical sense/meaning making or reasoning to some extent. For example, using concrete objects or manipulatives, videos, or illustrations that are animated or dynamic in some other way during classroom conversations. “Concrete objects” may include protractors, rulers, 2D models, or dynamic foldables as well as objects from everyday life.
This code does not include the visual support of the blackboard. Any visual support needs to add to the static nature of the blackboard, anchor charts, or other visually displayed information.	The key word here is “dynamic” in the sense of movement, change, or energy. Static supports such as black- or whiteboards, written materials or notes, PowerPoint slides, etc., are not captured by this code. Dynamic visual support needs to add to the static nature of the blackboard, anchor charts, or other visually displayed information.
	It is possible for ordinarily static supports like black-/whiteboard writing, formula/anchor charts, number lines, or times tables to be made dynamic through teacher or student actions such as annotation with arrows or circles accompanied by movement, physically acting out scenarios or ideas related to the supports, etc. However, simply including arrows or other static indicators of motion on a handout or chart does not count.

We are also developing and testing a new category aimed at capturing multilingual students’ use of what Schlepppegrell (2007) and others (e.g., Herbel-Eisenmann & Otten, 2011; Pimm, 1987) call the “classroom mathematics [linguistic] register.” Although elements of the classroom mathematics register are already captured in the QLDT+P code category “Meaning and multiple meanings of words,” this category is oriented towards students *learning about* differences in the mathematical and non-mathematical meanings of words, rather than *employing* such meanings. We feel that capturing moments when multilingual students capitalize on opportunities to use the classroom mathematics register is a potential gap in the current version of the QLDT+P. Hence, we have designed a new code to pilot during the next iteration of QLDT+P video analysis.

Discussion

The original combination of QLDT and EAR-MI rubrics captures many aspects of classroom mathematics instruction that are needed for multilingual students’ mathematics learning, including key sociocultural elements related to identity and positioning. We believe that our revised tool will allow for more nuanced and consistent assessment of quality mathematics instruction for linguistically diverse students. To test whether this is the case, we are training coders on the revised QLDT+P tool to analyze a new round of classroom videos generated by our larger, National Science Foundation-funded research project. These analyses, in turn, will generate insights not only about the reliability of the tool itself, but also about our broader research questions regarding the impact of a professional development on teachers’ quality of mathematics instruction for multilingual students. As such, our enterprise fits the 2023 PME-NA

theme of engaging all learners, addressing in particular the question of how to design learning environments that take students and learning into account.

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