Chapter 2
Teaching Mathematics to English Learners:
The Interplay Between Gestures and Discourse in Explaining Mathematical Concepts

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ABSTRACT

Recently, teachers in the United States are encountering an influx of multilingual immigrant students. The linguistic diversity can be challenging for teachers who need to think about how to foster language and disciplinary knowledge awareness in meaningful ways. Multimodal instruction (i.e., use of gesture, drawing, and movement) can serve to support conceptual understanding of emergent bilingual students in disciplinary areas such as mathematics or science. The purpose of this chapter is to investigate the interplay between gestures and mathematical concepts. This study takes place in a ninth grade ESOL Coordinate Algebra Classroom. Using systemic functional multimodal discourse analysis, the researchers analyze the teacher's gestures through a corpus of three video recorded lessons. The results show that the teacher's gestures endowed with meanings and mathematical concepts can enhance students' understandings. These findings can contribute to recent research on multimodal pedagogic practices among teachers with multilingual and multicultural students.

DOI: 10.4018/978-1-5225-9348-5.ch002

INTRODUCTION

Refrains such as "*Mathematics is a universal language, so students from different countries can understand it easily*" are frequently heard in pre-service and in-service teacher training courses. Arguably, if teachers have a strong knowledge of distinctive features of grammar, vocabulary, and genres of the texts in mathematics, they can design language-focused and instructional scaffolding that potentially fosters emergent bilingual learners' understanding (Schleppegrell, 2012). However, classrooms are increasingly multilingual (e.g., classrooms with nine or ten different languages) and this diversity will account for approximately 40% of the school-age population by 2040 (Berliner & Biddle, 1995). Amidst the current growing trend of a multicultural and multilingual student population, the question of how to handle multiple languages in one classroom is becoming critically important.

The academic trajectory of multilingual learners can be impacted dramatically by the type of instruction they receive, especially at the secondary level where the concepts become increasingly more complex. Advocates such as O'Halloran (2007a) argue for the need to develop theoretical framework and pedagogical practices to promote effective teaching strategies for ESOL teachers. Because of this demographic change in the U.S. classrooms, the tendency to support bilingual learners through frontloading of vocabulary and discrete elements of language becomes increasingly inadequate to support conceptual and semiotic (i.e. meaning) understanding of disciplinary constructs. Instead, multimodal meaning making (e.g. use of graphs, movement, drawing) need to enhance the learning experience for students in this increasingly multimodal world of technology. According to Lim (2011), "pedagogic semiosis (meaning-making) is a result of interplay of a repertoire of semiotic resources, not just language alone, expressed through a range of multimodalities" (p. 6). However, when studying pedagogic discourse and interaction between teacher and students, researchers traditionally concentrate on an analysis of classroom language alone (Sinclair & Coulthard, 1975; Mercer, 2000 and Walsh, 2006; 2011).

Classroom researchers focusing on language alone, such as verbal exchanges, tend to downplay or neglect the effects of meaning making through teachers' gestures. In addition, little effort is made to further examine how gesture is implemented effectively and can be used as mediational tools to make meaning in the mathematics classroom. In previous literature, indeed, the focus on gestures tended to be only on how they reinforce and clarify meanings already presented in speech alone (McNeill, 2012). Such perspectives neglected the contributions of symbolic imagery and physical movement to cognition and language learning. To contribute to the new dynamic focus on multimodal disciplinary instruction, this study investigated how gestures were used to help construct and communicate mathematical understandings in a multilingual classroom. To achieve this goal, the researchers participated in an 9th Coordinate Algebra ESOL Classroom and explored how the teacher of this class used his gestures to make meanings in mathematics, addressing the following question: *How were the ESOL math teacher's physical gestures endowed with mathematical meanings in a multicultural and multilingual classroom?*

BACKGROUND

Informed by functional linguists, language is not the only resource used in making meaning, but there are other resources e.g., visual displays, or graphs which teachers may use to construct meaning to learners (Kress, 2003). According to Kress and van Leeuwen (2006), to help make meaning in the classroom, full repertoire of meaning-making resources (e.g., action, visual, spoken, gestural, written, three-dimensional,