

Exploring Language in Bilingual and Multilingual Mathematics Classrooms

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In this paper, I explore ways in which language and mathematics may be used, perceived and learned in bilingual/multilingual mathematics classrooms. I propose a social view of mathematics that considers language, and in particular language in interaction, to be a crucial part of all mathematics classrooms, especially in bi/multilingual contexts. To begin, I reflect on the nature of the relationship between language and mathematics. In order to do so, I draw on key ideas from sociocultural theories of second language education and mathematics education, and from seminal research regarding the mathematics register. Focusing on the unique context of bi/multilingual mathematics classrooms extends the discussion. I conclude with suggestions for ways in which researchers and educators working in various bi/multilingual contexts can adopt a broadened view of mathematical discourse.

Language and Mathematics

What is the relationship, if any, between language and mathematics? In my own experiences as a high school French immersion mathematics teacher, and later as a doctoral student, I have had the chance to discuss with fellow educators, researchers and parents, the role of language in bi/multilingual mathematics classrooms. Conversations often consisted of seemingly contradictory phrases, for example, “mathematics is language free,” versus, “mathematics is its own language.” As Pimm (1987) has noted, mathematics in the school setting is often traditionally

seen as language free because it is viewed as a subject with clear-cut, right or wrong answers. There is very little or no room for ambiguity. From this standpoint, neither discussion nor negotiation has a place in a mathematics class. A contrary opinion is that mathematics is a language in its own right. This may be due to the fact that mathematics, including school mathematics, shares a number of similar traits with natural language, such as (a) a complex and rule-governed writing system, (b) an abstract nature, and (c) the use of symbols to represent objects. In addition, the often-sophisticated nature of mathematics operations and symbols can lead some to feel as though they are listening to or working with a language they do not understand. Notably, neither of these perceptions views mathematics as a particularly social or interactive activity.

I suggest that neither of these views (i.e., mathematics as language free vs. mathematics as a language) truly captures the essence, and the complexity, of the relationship between language and mathematics. An exploration of some seminal and more recent literature that underscores the social nature of language and mathematics learning can allow educators and researchers, like me, to better understand the relationship between language and mathematics and how it manifests itself in the bi/multilingual classroom environment.

The Mathematics Learning Register

For Halliday (1978), language is a fundamentally social enterprise: “At the most concrete level, this means that we take account of the elementary fact that people talk to each other” (p. 2). This view of language acknowledges the forms used (e.g., words, sentences), but focuses on the exchange of meanings that

occurs during interpersonal interactions. When examining language in this way, there are always three important questions to consider: (a) What is taking place? (b) Who is taking part? and (c) What part is the language playing? Taken together, the answers to these questions determine the meanings selected and the forms used to express those meanings; in other words, the answers to these questions within any given context determine the language *register*. Mathematics is one of many contexts within which a particular register is used. The mathematics register is made up of the meanings (e.g., canonical mathematical meanings, everyday meanings), words and structures (e.g., vocabulary, style, modes of argument, grammar), and symbols (e.g., symbols, numbers, letters) that are appropriate to the mathematical function of language (Halliday, 1978; Pimm, 1987).

The mathematics register helps describe the specialized language of mathematics. However, some researchers in mathematics education (Barwell, 2009; Moschkovich, 2007, 2010; Pimm, 2007) have narrowed their focus in order to explore the particular context of the mathematics classroom and, more specifically, the bi/multilingual mathematics classroom. Within this environment, the mathematics register can be elaborated as a mathematics learning register: the specialized language of the mathematics classroom. Although mathematical classroom discourse cannot be reduced to a homogeneous set of practices as it varies across individuals, times, settings, and purposes, a number of defining characteristics can be identified. A mathematics learning register focuses on the social nature of mathematics and the classroom environment, and on the practice of meaning making that occurs within this context. The discourse of the mathematics classroom involves ways in which students talk, act, interact, think, believe, read, write, search for certainty,

generalize, and imagine. It also considers students' various mathematical points of view and values the mathematical knowledge brought forth through their "everyday" talk (Moschkovich, 2007). When viewing classroom mathematics in this way, I and other researchers and educators can adopt a broadened view of what constitutes mathematical discourse and thus value the knowledge that students bring to the table. While this is key for any mathematics classroom, viewing mathematical classroom discourse in this way can be especially important if we are to value the linguistic and mathematical resources of our bi/multilingual students.

A Sociocultural Theory of Language and Mathematics

Sociocultural theory is commonly used as a theoretical framework in the field of second language education by researchers who are interested in exploring (among other things) how students use and learn second and additional languages through oral interaction. This work is heavily rooted in Vygotsky's (1962, 1978) ideas regarding the social nature of individual cognition. Viewing language through a sociocultural lens highlights how knowledge is co-constructed among interpersonal interactions and becomes internalized within individuals. Vygotsky described a number of cultural tools used by individuals during these meaning-making interactions, the most important of which is language (Wertsch, 1993). During interpersonal interactions, language is not only a communicative but also a cognitive tool; it is not only a conveyor but also a mediator of thought (Swain, 2008). Conceptualizing language as such, second language researchers (e.g., Lantolf, 2000; Swain, 2000, 2008) have underscored the importance of collaborative dialogue and

scaffolding in the bi/multilingual language classroom, and how language use and language learning occur simultaneously.

Taken together with the ideas embedded within the mathematics learning register, sociocultural theory provides a solid theoretical foundation for an exploration of the relationship between language and mathematics, particularly in a bi/multilingual classroom context. A sociocultural theory of language and mathematics considers both to be social, discursive, meaning-making activities, which are heavily influenced by the contexts in which they are occurring.

Research in Bilingual and Multilingual Mathematics Classrooms

Mathematics education researchers have identified a need for more research on “what is actually happening in classroom interactions, on the nature of communication among students...and on the effects of particular language choices” (Morgan, Craig, Schüte, & Wagner, 2014, p. 846). Approaching research in bi/multilingual classrooms with a theoretical framework that includes sociocultural theories of language and a focus on a mathematics learning register represents an important starting point. However, there are a number of further considerations (tensions) that must be reflected upon prior to and while conducting research within the specialized context of bi/multilingual mathematics classrooms.

Within this context are several sub-contexts; each of these environments is unique and governed by its own norms, values, discourses, policies, and politics. Across the globe, official language bilingual programs (e.g., immersion), heritage language programs, indigenous language programs, mainstream English

programs for non-official minority or majority language speakers, and mainstream English programs in highly multilingual societies, are just a few examples of the different types of bi/multilingual mathematics classrooms that exist. Barwell (2009, 2010), nonetheless, has identified five tensions that are present in all bi/multilingual mathematics classrooms. Any researcher conducting a study in such an environment must be cognizant of the following tensions between:

1. language and mathematics,
2. formal and informal language used to discuss mathematics,
3. students' home language(s) and the official language of schooling,
4. mathematical understanding and the social value of a second (or additional) language, and
5. policy goals and classroom practice.

These tensions influence which languages are used and valued in the classroom, and consequently how language(s) and mathematics are taught and learned.

Conclusion

Sociocultural theory and a mathematics learning register offer a theoretical orientation for researchers and educators interested in exploring language and mathematics in bi/multilingual classrooms in a deep and meaningful way. This resource-based, as opposed to a deficit-based, perspective focuses on interaction and views language as a social activity and a cognitive tool, and mathematics as a social and cognitive enterprise. Through this lens, multiple meanings are valued, and mathematical discourse is not merely numbers, symbols, and vocabulary but includes argumentation, precision, generalizing, and imagining. With regard to bi/multilingual classroom research

in particular, there is a clear need to contextualize the politics and policies of the classroom, to acknowledge and explore the inherent tensions present, and to value the multiple resources that students can offer. Recognizing that language and mathematics exist in an interwoven, complex, social relationship and broadening our view of this relationship can allow researchers like me to gain a better understanding of how language and mathematics learning co-occur in bi/multilingual mathematics classrooms. After all, as Barwell, Leung, Morgan, and Street (2005) have pointed out, “language is about more than words; mathematics is about more than numbers” (p. 146).

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