

# Teachers of Emergent Bilinguals: Contextualizing the Mathematical Knowledge for Teaching Framework

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## Abstract:

Teaching mathematics to emergent bilingual students presents unique challenges and opportunities for educators. In this paper, we propose a framework for contextualizing the Mathematical Knowledge for Teaching (MKT) framework within the specific needs and contexts of emergent bilingual learners. By integrating research on language acquisition, culturally responsive teaching practices, and effective mathematics instruction, this framework aims to support teachers in developing the knowledge and skills necessary to effectively teach mathematics to emergent bilinguals.

The proposed framework builds upon the foundational components of the MKT framework, which include knowledge of content, pedagogy, and students. However, it extends these components to address the linguistic and cultural dimensions of teaching mathematics to emergent bilinguals. Key elements of the framework include:

**Language Awareness:** Teachers develop an understanding of the linguistic resources available to emergent bilingual students and how language impacts mathematical learning. This includes knowledge of language acquisition processes, language registers, and the role of language in mathematical reasoning.

**Cultural Responsiveness:** Teachers recognize and value the diverse cultural backgrounds and experiences of emergent bilingual students. They integrate culturally relevant examples, contexts, and teaching strategies to make mathematics meaningful and accessible to all students.

**Pedagogical Strategies:** Teachers employ a range of instructional approaches that promote language development and mathematical understanding among emergent bilingual students. This may include scaffolding, modeling, cooperative learning, and differentiated instruction tailored to students' language proficiency levels.

**Assessment and Feedback:** Teachers design assessments that account for the linguistic and cultural diversity of emergent bilingual learners. They provide timely and constructive feedback that supports students' language development and mathematical growth.

**Professional Collaboration and Reflection:** Teachers engage in ongoing collaboration with colleagues and reflection on their practice to continuously improve their effectiveness in teaching mathematics to emergent

bilinguals. This may involve peer observation, professional learning communities, and participation in culturally responsive teaching workshops.

By integrating these elements into the MKT framework, teachers can enhance their capacity to meet the needs of emergent bilingual students and foster their success in mathematics. This framework provides a comprehensive guide for teacher preparation programs, professional development initiatives, and classroom practice aimed at supporting the mathematical learning of emergent bilinguals.

**Keywords:** *Emergent bilinguals, mathematical knowledge for teaching, language awareness, cultural responsiveness, pedagogical strategies, assessment, professional collaboration, reflection.*

## Introduction

### Literature overview

Teachers' Mathematical Knowledge for Teaching (MKT) refers to the specialized knowledge and skills that educators possess to effectively teach mathematics to their students. Developed through education, professional development, and classroom experience, MKT encompasses a range of competencies that enable teachers to facilitate meaningful learning experiences and support students' mathematical understanding.

### **The MKT framework consists of several interconnected components, including:**

**Knowledge of Content:** Teachers' understanding of mathematical concepts, procedures, and principles. This includes knowledge of mathematical structures, relationships, and connections within and across mathematical domains.

**Pedagogical Content Knowledge (PCK):** The knowledge and skills required to teach specific mathematical concepts effectively. This includes knowledge of instructional strategies, representations, and approaches that support students' learning and problem-solving abilities.

**Knowledge of Students:** Teachers' awareness of their students' mathematical strengths, challenges, and diverse learning needs. This includes knowledge of students' prior knowledge, misconceptions, cultural backgrounds, and individual differences that may impact their mathematical learning.

**Knowledge of Curriculum and Standards:** Familiarity with mathematics curriculum frameworks, standards, and learning objectives. Teachers understand the scope and sequence of mathematical topics, as well as the goals and expectations outlined in national or state standards.

**Knowledge of Assessment:** The ability to design and implement effective assessments to evaluate students' mathematical understanding and monitor their progress over time. This includes knowledge of formative and summative assessment strategies, as well as methods for interpreting and using assessment data to inform instruction.

**Knowledge of Instructional Strategies:** Knowledge of a variety of instructional approaches, methods, and techniques for teaching mathematics. Teachers employ research-based pedagogical practices, such as inquiry-based learning, cooperative learning, and differentiated instruction, to engage students and promote mathematical understanding.

**Knowledge of Technology:** The integration of technology tools and resources to enhance mathematics instruction. Teachers use digital technologies, interactive software, and online resources to support students' mathematical exploration, problem-solving, and communication skills.

**Knowledge of Equity and Diversity:** Awareness of issues related to equity, diversity, and social justice in mathematics education. Teachers recognize and address barriers to learning, advocate for inclusive practices, and provide culturally responsive instruction that affirms students' identities and experiences.

## **Subject Matter Knowledge (SMK) within the EBs' context**

Subject Matter Knowledge (SMK) within the context of Emergent Bilinguals (EBs) refers to teachers' deep understanding of the content they teach, specifically tailored to meet the needs of students who are learning English as an additional language. SMK encompasses not only proficiency in the subject matter itself but also the ability to scaffold instruction, differentiate content, and make connections between language and content knowledge to support EBs' language development and academic achievement in the subject area.

### **Key components of SMK within the context of EBs include:**

**Language-Integrated Content Knowledge:** Teachers integrate language and content instruction, recognizing the interdependence between language development and academic learning. They use strategies such as language modeling, explicit language instruction, and language-focused activities to make content accessible and comprehensible for EBs while promoting academic language development.

**Cultural Relevance:** SMK within the EBs' context involves incorporating culturally relevant content and examples that resonate with students' backgrounds and experiences. Teachers draw upon students' cultural assets and leverage culturally responsive teaching practices to make connections between the subject matter and students' lived experiences, fostering engagement and relevance.

**Differentiation and Scaffolding:** Teachers differentiate instruction to meet the diverse needs of EBs, providing varying levels of support and challenge based on students' language proficiency levels and academic readiness. They scaffold instruction by breaking down complex concepts, providing linguistic and conceptual supports, and gradually releasing responsibility to students as they develop proficiency.

**Assessment and Feedback:** Teachers design assessments that align with EBs' language proficiency levels and cultural backgrounds, using multiple measures to assess both content knowledge and language development. They provide timely and constructive feedback that supports EBs' language learning and academic growth, using assessment data to inform instructional planning and differentiation.

**Collaboration and Professional Learning:** SMK within the EBs' context involves collaboration with colleagues, specialists, and community resources to support EBs' language and content learning. Teachers engage in professional learning communities, attend workshops and training sessions, and seek out resources and strategies that enhance their ability to effectively teach EBs in the subject area.

**Advocacy and Equity:** Teachers advocate for equitable access to high-quality content instruction for EBs, recognizing and addressing systemic barriers to learning. They advocate for policies, programs, and resources that support EBs' linguistic and academic development, ensuring that all students have the opportunity to succeed in the subject area regardless of language background.

### **Pedagogical Content Knowledge (PCK) within the EBs' context**

Pedagogical Content Knowledge (PCK) within the context of Emergent Bilinguals (EBs) refers to teachers' specialized understanding of how to effectively teach mathematics while considering the linguistic and cultural backgrounds of EB students. It encompasses the intersection of pedagogical strategies and content knowledge, tailored to meet the diverse needs of EB learners. Here's a breakdown of PCK within the EB context:

**Understanding Language Development:** Teachers with PCK for EBs are knowledgeable about the stages of language acquisition and the unique linguistic challenges faced by emergent bilingual students. They understand how language proficiency impacts mathematical learning and adapt their instruction accordingly.

**Culturally Responsive Pedagogy:** PCK for EBs involves incorporating culturally relevant teaching practices that honor the linguistic and cultural diversity of students. Teachers recognize and value the cultural assets that EB students bring to the classroom, integrating students' cultural backgrounds into mathematical instruction to make concepts more meaningful and accessible.

**Differentiated Instruction:** Teachers with PCK for EBs employ a variety of instructional strategies to meet the diverse needs of EB learners. They use scaffolding techniques, provide multiple representations, and offer opportunities for language practice to support students at varying levels of language proficiency.

**Language-Supportive Environment:** PCK for EBs involves creating a classroom environment that supports language development while learning mathematics. Teachers provide opportunities for students to engage in meaningful mathematical discourse, use language-rich tasks and materials, and encourage peer collaboration to enhance language acquisition and mathematical understanding simultaneously.

**Assessment and Feedback:** Teachers with PCK for EBs design assessments that align with the language proficiency levels of EB students and provide feedback that supports both mathematical learning and language development. They use formative assessment strategies to monitor students' progress and adjust instruction to

address their evolving needs.

**Family and Community Engagement:** PCK for EBs includes strategies for involving families and communities in students' mathematical learning. Teachers recognize the importance of partnering with families to support students' language and mathematical development at home and seek to build strong connections with culturally and linguistically diverse communities.

**Technology Integration:** Teachers leverage technology tools and digital resources to enhance mathematical learning experiences for EB students. They select technology platforms and applications that support language development and provide opportunities for interactive, language-rich mathematical exploration and practice.

#### Setting and participants

Participants were 16 PSTs, 15 of them identifying as women and one as a man, enrolled in a teacher-preparation program at a university located in the southwest area of the United States. Six PSTs self-identified as White, seven as Latinx/Hispanic, and three as Asian. All 16 PSTs were in their penultimate semester of their teacher-preparation program enrolled in Elementary Mathematics Methods, a course designed to expose PSTs to research-based recommendations for the learning and instruction of K-5 mathematics. Eight of the PSTs were in the same cohort pursuing a degree in Early Childhood to Sixth Grade Generalist Certification with the additional requirement to be certified in teaching as ESL teachers. The remaining eight PSTs were enrolled in a separate cohort pursuing the same bachelor's degree but with a focus on teaching bilingually (English and Spanish). Regardless of the degree, both cohorts had already taken the same amount of coursework that focused specifically on the education of bilingual, bicultural, and biliterate children in the United States. Furthermore, due to the high degree of Latinx/Hispanics in the surrounding communities, their teacher-training placements had all been, thus far, in classrooms that had at least 50% of EBs present.

## Results

The analysis of the interviews led to the identification of six underlying subthemes pertaining to the PSTs' beliefs about the mathematics education of EBs. In this section, we present findings that illustrate the subthemes that emerged and their relationship within the contextualized MKT framework. It is important to note that these subthemes, and the entire contextualization of the MKT for that matter, are not to be taken as mutually exclusive from each other but rather as a continuation in an effort to address the need of a stronger mathematics experience for EBs via multiple angles.

### **Content Knowledge (CCK): The non-universality of mathematics**

Content Knowledge (CCK) in the context of the non-universality of mathematics refers to teachers' understanding of the cultural, historical, and contextual factors that influence the ways in which mathematical concepts are constructed, interpreted, and applied across different cultural and societal contexts. Unlike some other subjects, mathematics is not universally understood or interpreted in the same way across all cultures and

societies. Therefore, teachers with CCK recognize the importance of considering cultural perspectives and diverse mathematical traditions when teaching mathematics. Here are some key aspects of CCK related to the non-universality of mathematics:

**Cultural Mathematics:** Teachers with CCK acknowledge that mathematical concepts and practices can vary significantly across cultures. They understand that different cultures may have distinct approaches to mathematical problem-solving, reasoning, and representation. For example, some cultures may place greater emphasis on oral mathematical traditions, while others may prioritize written or visual representations.

**Historical Context:** CCK involves an awareness of the historical development of mathematical ideas and concepts within different cultures. Teachers understand how historical events, societal norms, and intellectual traditions have shaped the evolution of mathematics in diverse cultural contexts. They recognize the contributions of mathematicians from various cultural backgrounds and incorporate historical perspectives into their instruction.

**Ethnomathematics:** Teachers with CCK are familiar with the concept of ethnomathematics, which refers to the study of mathematical practices and concepts within specific cultural groups. They recognize that ethnomathematical traditions may differ from mainstream mathematical practices and may include unique problem-solving strategies, numerical systems, and geometric principles. Teachers incorporate examples of ethnomathematics into their instruction to broaden students' perspectives and promote cultural diversity in the mathematics classroom.

**Cultural Relevance:** CCK involves selecting and adapting mathematical content and instructional materials to make them culturally relevant and meaningful to students from diverse cultural backgrounds. Teachers seek out culturally diverse examples, contexts, and real-world applications of mathematics that resonate with students' lived experiences and cultural identities. By making mathematics culturally relevant, teachers help students see themselves reflected in the subject and foster a sense of belonging and engagement in mathematical learning.

**Cross-Cultural Communication:** Teachers with CCK are sensitive to the linguistic and cultural diversity of their students and recognize the importance of effective cross-cultural communication in the mathematics classroom. They employ instructional strategies that promote communication and collaboration among students from different cultural backgrounds, such as group work, cooperative learning, and peer tutoring. Additionally, teachers may use multiple modes of communication, including verbal, written, and visual, to accommodate students' diverse language abilities and cultural preferences.

## Conclusion

The identification of contextualized, practical actions we may take to keep promoting equitable mathematical practices for EBs was made feasible by the findings. This necessitates that PSTs acquire abilities including

emphasizing the linguistic demands that are inherent in mathematics, the many kinds of language assistance programs that are provided in math classrooms, and general research-based teaching strategies. PSTs must simultaneously cultivate an ideology toward mathematics that is sufficiently flexible while maintaining its integrity as a mathematical discipline to provide equal learning opportunities for students whose contributions and knowledge may differ from conventional or traditional mathematical practices.

These results do have certain limits, though. First of all, it is important to note that evaluating, much alone summarizing, the high level of complexity associated with EBs' fair mathematical education requires more than a sample of 16 PSTs. An further constraint pertains to the inherent effect of the researcher's viewpoint on qualitative endeavors, encompassing data collection, analysis, and synthesis. Finally, the PSTs chosen for this investigation were still enrolled in their teacher preparation course.

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