THE MATHEMATICS EDUCATION OF ENGLISH LEARNERS

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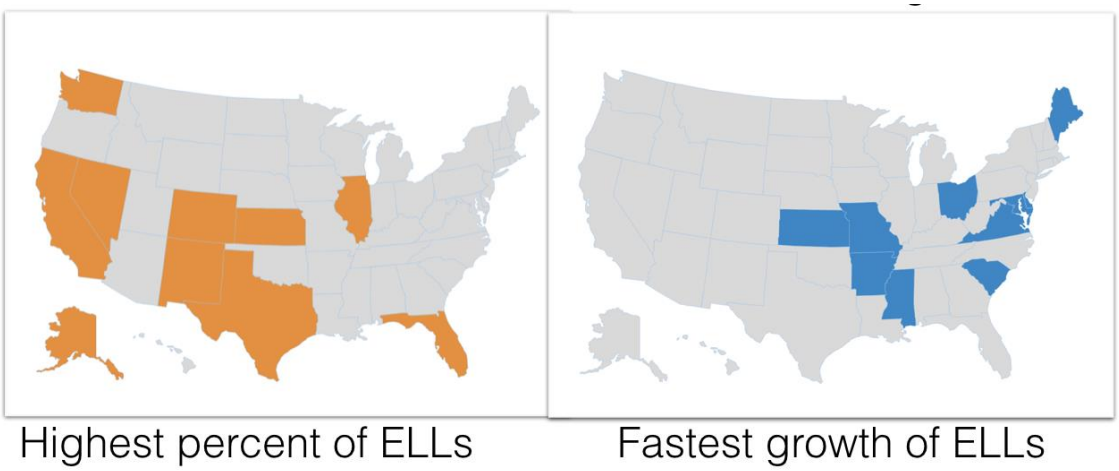
This Working Group builds on the accomplishments of the Working Groups in 2015, 2016, and 2018. We will continue considering multiple aspects of research and practice related to mathematics learning and teaching with English Learners. Our goals for the 2019 Working Group include: (1) sharing an opportunity to publish empirical research related to mathematics and English learners; (2) identifying additional venues for dissemination of mathematics education research on English learners, including novel outlets that connect research to practice; and (3) developing and refining the work that will be shared. In Session 1, the organizers will engage participants in a structured sharing and offer feedback using a protocol. During Session 2, we will engage in a second round of co-working to improve our developing empirical studies. In our final day of the Working Group, we will discuss alternative outlets for sharing our work. We will close with time to review group progress and discuss next steps for our collective and individual work.

Keywords: Equity and Diversity

Introduction/Rationale

English Learners (ELs) are the fastest growing group of U.S. students (Verplaetse & Migliacci, 2008). U.S. schools have seen an increase in the percentage of ELs in all but 10 states between 2000 and 2015 (National Center for Educational Statistics [NCES], 2017). This increase in the population of ELs has created a need for schools and teachers to create inclusive and equitable mathematics classrooms. No longer is supporting ELs a concern only for educators in states like Arizona, Texas and California with traditionally high numbers of EL students. With all but 15 states across the country seeing increases in their EL populations between 2004-05 and 2014-15 (NCES, 2017), there is growing nationwide pressure for support in addressing the needs of these students. (Figure 1).



Otten, S., Candela, A. G., de Araujo, Z., Haines, C., & Munter, C. (2019). *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. St Louis, MO: University of Missouri.

Figure 1: The 10 states with the highest percent of ELs in 2016 (left) and the 10 states with the fastest growth in EL population (right). (Source: National Center for Educational Statistics) https://nces.ed.gov/programs/coe/indicator_cgf.asp

This year, our Working Group aims to look backward to synthesize research related to the mathematics education of ELs, while also looking forward to consider new opportunities to publish research in the field. We will focus on the question: How can we produce empirical research that addresses gaps in the literature related to the mathematics education of English Learners?

In looking back at research that the field has completed, the organizers will share insights from a recently completed a literature review of research on ELs and mathematics education (de Araujo, Roberts, Willey, & Zahner, 2018). We will also discuss the political landscape in relation to this work, as we acknowledge the sociocultural and political dimensions of mathematics, school mathematics, and the complex intersection of language(s) culture and mathematics in multilingual settings (Gutiérrez, 2013). There is still much work to be done; some contexts and critical dimensions of the question of how best to educate English learners in mathematics remain unexamined. During this meeting of the working group, we will look forward as a group to continue to contribute to the field and to consider the contexts, dimensions, and work that still needs to be done related to ELs and mathematics education. The product of this Working Group will be a special issue in a research journal focusing on ELs in mathematics education, which features the empirical research discussed in this Working Group.

Brief History of the Working Group

The facilitators of this Working Group initially came to work together through the NSF-funded Center for the Mathematics Education of Latinas/os (CEMELA). CEMELA brought together researchers from across the country to collaborate on research focused specifically on critical issues related to Latinos/as in mathematics. Prior to CEMELA, researchers interested in such a focus worked mostly in isolation. In considering issues related to Latinos/as in US schools, issues of language and culture were central to CEMELA's work, which often had direct implications for ELs more broadly. While not all Latinos/as are ELs, and not all ELs are Latinos/as, these two groups have significant overlap. For example, about 80% of ELs speak Spanish as a first language, and Spanish-speaking ELs appear to struggle on measures of academic achievement (Goldenberg, 2008).

CEMELA expanded the field's knowledge of ELs in mathematics through conducting interdisciplinary studies that helped researchers and practitioners better understand the reality of Latinas/os and mathematics teaching and learning. CEMELA's research focused on teacher education, research with parents, and research on student learning, resulting in over 50 publications and presentations. Again, several of these studies involved the investigation of questions related to the interplay of language, culture, and mathematics education. CEMELA also had the goal of connecting the network of scholars focused on these issues, as a means to build capacity and sustain the work.

Following the conclusion of CEMELA's funding, Zandra de Araujo, Sarah Roberts, Craig Willey, and William Zahner continued to meet regularly. These meetings focused on examining intersections among these early career scholars' work related to the mathematics education of ELs. To date these meetings have resulted in a number of national presentations at the annual meetings of the National Council of Teachers of Mathematics, the American Educational

Research Association, and PME-NA. Currently, this group is working on several manuscripts and follow-up studies related to the preparation of teachers to work with ELs. Perhaps most notable is an extensive review of the international literature focused on mathematics and ELs (de Araujo et al., 2018).

The Mathematics Education and ELs Working Group met at PME-NA in 2015 (de Araujo et al., 2015), 2016 (de Araujo et al., 2016), and 2018 (de Araujo et al., 2018). At those meetings, we brought together a diverse group of about 30 researchers who started working together on several projects related to the mathematics education of ELs (see descriptions of these projects in the section below titled *Previous Work of the Group*). Our aim for the 2019 Working Group is to provide a space for these scholars to continue their work, to focus on producing and sharing products from our research, and to bring new scholars into the fold.

Previous Work of the Group

The 2015 and 2016 Working Groups (de Araujo et al., 2015, 2016) began with whole group discussions aimed at examining five aspects related to the mathematics education of ELs including: a) Student Learning; b) Family and Community Resources; c) Language Perspectives; d) Teacher Education; and e) Curriculum. In the following sections we briefly summarize our discussions and subsequent work in each of these areas.

Student Learning

Building upon situated and sociocultural perspectives (Moschkovich, 2002), the student learning group started from the premise that ELs, like all students, learn mathematics through a process of appropriating discourse practices, tool use, and perspectives of mathematics. In reviewing the literature on the mathematics learning of ELs, we have identified a need to better understand how research in mathematics education at large is connected with research on the mathematics learning of ELs. Much of the content-focused work in mathematics education is isolated from research on how ELs develop specific mathematical understandings. Previous discussions at this Working Group have supported ongoing research and development efforts focused on bridging the literature on supporting ELs in mathematics classrooms and the literature on students' mathematics learning through focused instruction.

Family and Community Resources

Families and communities can serve as resources for ELs in their mathematics learning in myriad ways. Families can advocate for their children and provide and support learning experiences both in and out of the classroom. Communities can also provide a wealth of support mechanisms and learning possibilities. Moll, Amanti, Neff, and Gonzalez (1992) described how students studied candy making and selling within their neighborhood to explore mathematics within this context, such as discussing and analyzing production and consumption. In doing so, the teachers and students acknowledged the value of these community experiences. Additionally, Civil and Bernier (2006) explored the challenges and possibilities of involving parents in facilitating workshops for other parents around key math topics. These studies and others like them illustrate the promise of family and community resources in fostering ELs' mathematics learning. At our 2015 meeting, Civil shared her recent work on how school language policies impact ELs' engagement and how teacher educators can draw on family and cultural resources in support of ELs. We followed up on this work during our 2016 with small group discussions.

Language Perspectives

Teachers' and researchers' conceptions of language, second language acquisition, and bilingualism affect teaching and learning mathematics for ELs. In 2015, Judit Moschkovich

shared her work, highlighting how perspectives of language, second language acquisition, and bilingualism appear in both theory and practice. We also discussed, in particular, how work focused on ELs can draw on current work on language and communication in mathematics classrooms, classroom discourse, and linguistics. Looking for these intersections and connections was crucial, because it ensures that work in mathematics education is both theoretically and empirically grounded in relevant research, preventing researchers from reinventing wheels.

Teacher Education

Much of the prior work on teacher education related to ELs has focused on more general strategies (e.g., sheltered instruction, as in Echevarria, Vogt, & Short, 2007), such as using visuals, modifying texts or assignments, and using slower speech. We argue there is a need for content-specific support for mathematics teachers of ELs. At our previous meetings, we explored ways to support teachers, both pre-service and in-service, in better understanding students' strengths and meeting the needs of ELs in the mathematics classroom.

During the 2015 and 2016 Working Groups, the teacher education subgroup focused on the primary issues that arise in the preparation of teachers to teach ELs at the various institutions. As a group, we recognized that there were few attempts to include the teaching and learning of mathematics to ELs beyond the states where there was a high population of ELs. Given that some of the group members were meeting for the first time, a significant portion of the allotted time was spent sharing the details of the research we did and our interest in being part of this particular subgroup. One of the members shared a survey about examining preservice teachers' conceptions about teaching mathematics to ELs, and the other members agreed to administer the survey at their locations. Together, the responses could provide us with some insight about possible conceptions that need change and the steps we can take to make that happen. The group stayed in touch online and continued the discussions about potential collaborations.

Curriculum

In 2015, the curriculum subgroup focused on the role of textbooks, specifically teachers' guides and student work pages, in demonstrating how one might approach supporting ELs in building mathematical understanding and developing mathematics language. We inquired about the process publishers undergo to incorporate and offer support to teachers. What assumptions do they make? Who do they consult? What motivates them to invest in serving ELs better? What is/are their end goal(s)? The group decided to conduct an analysis of various middle grades curriculum to ascertain what supports and guidance are offered to teachers. It was suggested that we might build on the work of Pitvorec, Willey, and Khisty (2010), who explored the features of Finding Out/Descubrimiento (FO/D) that proved to be successful with bilingual children of migrant families in the 1980's and partially contributed to the development of complex instruction (Cohen, Lotan, Scarloss, & Arellano, 1999).

At the 2016 meeting, this group continued to examine textbooks to understand better the supports they provide for ELs. Participants considered language issues in mathematics texts for ELs, especially as related to word problems and assessment items. We shared a short literature review of relevant research on linguistic complexity and vocabulary for mathematics word problems. Based on that research, we summarized recommendations for addressing language complexity and vocabulary in designing word problems for instruction, curriculum, or assessment. We then used examples of released sample Smarter Balanced Assessment Consortium items to illustrate how to apply those recommendations to design word problems and to design supports for ELs to work with word problems. Several of the participants have

continued this work examining curriculum accommodations for ELs and are completing a research study based on the work started at the 2016 Working Group.

2018 Working Group

The 2018 Working Group was an opportunity to share recent empirical work from members of the group and to provide participants with a chance to engage in discussions around data collection and analysis. During the first half of the working group, several members presented current research. For example, Erin Smith presented her work on curriculum supports for ELs in elementary mathematics classrooms. Marta Civil introduced the Working Group to the forthcoming National Academy's (2018) *English Learners in STEM Subjects* report, on which she had contributed. Sarah Roberts shared a framework she and a colleague have developed for supporting ELs that they use in their content methods course. Such presentations represented topics from a variety of researchers who conduct research across the spectrum of grade bands and contexts of research previously mentioned. Zandra de Araujo wrapped up these presentations by sharing an overview of the findings of the literature review of de Araujo et al. (2018). These presentations provided an overview of a variety of research taking place in the field around English learners and mathematics, and with the literature review presentation and the National Academy report, some of the research that is currently lacking.

The second half of our 2018 Working Group was dedicated to a *data dive*. In the first part of the activity, participants learned about Bill Zahner's NSF CAREER study. He then introduced the group to a framework he has developed for linguistic and mathematical demands (Zahner, Milbourne, & Wynn, 2018). The group used this framework to analyze a task and interviews from his study, entering into the *data dive*. The Working Group considered transcripts, the accompanying audio, student work, and the original task.

Sharing this existing work along with participating in the data dive engaged the Working Group in conversations around data. Our discussions and activities during the 2018 Working Group allowed us to model and to discuss analysis and data collection. Now members of the Working Group have works in progress that they are getting ready for dissemination. In 2019, we will focus our efforts on dissemination, providing structured time together for improving the products of our research. Between March 2019 and November 2019, the Working Group organizers will be proposing a special issue to journal editors to lay the foundation for this group publication.

Aims for the 2019 Working Group

Previous meetings of this Working Group have brought together a large and diverse group of attendees. For example, in 2016 there were approximately 30 attendees including teachers, preservice teachers, researchers, graduate students, and teacher educators from a range of institutions. In 2018, the Working Group attendees included experienced leaders in the field, mathematics education faculty with experience in the topic of English learners in mathematics who were still at the early stages of their careers, and graduate students and faculty who were new to the topic of English Learners in mathematics. During the 2018 meeting, we successfully shared some of our existing and in-progress research in the form of presentations. For the 2019 iteration of this Working Group, we propose to narrow our focus and to home in on the goal of producing high-quality scholarship in widely accessible venues. Our goals for the 2019 meeting include: *(1) sharing an opportunity to publish empirical research related to mathematics and English learners; (2) identifying additional venues for dissemination of mathematics education research on ELs, including novel outlets that connect research to practice; and (3) developing*

and refining the work that will be shared. The goal for 2019 will be realized through specific activities and interaction formats. These activities include: (1) structured time for participants to share their existing work; (2) structured feedback protocols through which participants can offer constructive feedback with the goal of advancing the quality of our research, and (3) concrete discussions of timelines and plans for publication of our work in a refereed journal as well as alternative forms of dissemination.

Plan for the 2019 Working Group Sessions

During the three sessions in 2019, participants will engage in collaborative efforts related to dissemination and the production of research based on the prior research of Working Group participants. Each meeting of this Working Group at PMENA will have a narrow focus. Prior to the Working Group, we will contact past participants and invite them to come to the 2019 Working Group with a paper in progress for discussion and feedback sessions. We will also send out an email to the PMENA list-serv and offer this as an option to new participants, to capture individuals who may be working on papers and would fit in the session.

Participants who wish to receive feedback on their manuscripts in progress will be asked to upload draft work ready to be shared and workshopped in a working group format before the first meeting. Aware that some members will be new in 2019, we will invite new members to join in the shared writing and editing efforts using Google Docs or a similar tool to share files as appropriate.

Session 0 (Pre-PME-NA): Propose Special Issue & Virtual Study Group

The summer before PMENA 2019, we will propose two special issues on ELs in mathematics to peer reviewed journals. One issue will be written for a research audience and the other will address teachers. We will also build momentum for the working group before the PMENA meeting by organizing a virtual study group in which potential Working Group members can participate. Over the course of six sessions, we will meet monthly and organize a study space around translanguaging in mathematics classrooms. The group will be open to anyone who is interested in learning more about translanguaging to inform their teaching and/or scholarship. This will also allow us to provide an introduction to the special issue and possible contributors.

Session 1: Introductions and Brief Reports

The initial session will include some time to allow participants to meet fellow attendees and to share current perspectives on extant research related to mathematics and English learners. The organizers will present a brief report on the outcomes of prior working groups. Then we will share goals for this year's iteration of the Working Group. After this preliminary step, we will devote a substantial amount of time to sharing and workshopping three manuscripts that are close to completion.

Activities

- Brief (re)introduction to the Working Group.
- Sharing of 3 papers by potential contributors to the special issue.
- Structured feedback to authors.

The structured feedback will happen in small groups. Participants in the Working Group will be divided into groups and invited to read an excerpt of each authors' work and then offer constructive feedback that can be used to refine the manuscripts in development. Feedback will

be structured to maximize the probability that the feedback is useful to authors. Guiding Questions for the feedback will be:

1. What does this paper add to the literature on mathematics education and English learners?
2. Are the frameworks (theoretical and conceptual), research questions, methods, analysis, and claims aligned? If not, how can the author bring these elements into alignment?
3. Are the discussion points illuminating in relation to the literature review and the existing state of knowledge in this field? Is there anything that should be added to the discussion to make it more powerful?

At the end of session 1, the authors who will be sharing work in session 2 will give a brief (1 minute) precis of their work. Participants will be divided into groups and assigned to one author. The author will give these participants access to a manuscript in progress that they will read before Session 2.

Session 2: Continued Workshopping

Session 2 will have a structure similar to Session 1. In Session 2, three more potential contributors to the special issue will share their work. This will follow a format similar to the format of Session 1: Each potential author will give an overview of their work in the form of a short Powerpoint. Then the Working Group will divide into subgroups in which the members of the Working Group provide structured feedback to authors.

We will conclude Session 2 with an overview of some of the general themes of the articles and the feedback that authors are receiving. This work is twofold. First, it helps to begin to organize the special issue topically. Second, it helps the authors to consider some of the major feedback that authors are receiving and how that might support their writing moving forward. What are some of the missing pieces across the manuscripts? With what are authors conceptually struggling? How can we make our methods stronger to make arguments stronger? These conversations will help us wrap-up our second day.

Session 3: Consider Alternative Modes of Sharing Work

Aware that much of our work winds up in journals that are only read by other researchers, on Day 3 of the Working Group, we will convene a discussion of potential alternative modes of sharing the work we produce. We will consider the following outlets: video exemplars, blog posts, op-eds, apps, curriculum production/development, professional development. We will invite a panel who has completed such work to share their experiences, challenges, successes, and suggestions. This will take the first half of the last day of our Working Group.

During the last half of our final day of Working Group, we will create a timeline for our collective and individual next steps of the special issue and for participants' individual manuscripts.

Follow-up Activities

We anticipate that this Working Group will again attract other researchers interested in issues related to the mathematics education of ELs. Therefore, an important component of this fourth meeting of the Working Group will be to maintain current relationships while also continuing to establish connections with other interested researchers in order to build opportunities for future collaborations. We will provide space for new researchers to contribute to our collective work, to suggest new directions, and to add to the growing body of research on mathematics and ELs. At the first session of our Working Group, we will share our ongoing online Google Community,

which uses Google applications (Hangout, Groups, Drive, etc.). Google's applications are freely available and allow for a number of collaborative opportunities, including video conferencing, group messaging, collaborative document development, and shared web and social media space. Through this collaborative Google Community, we have organized follow up meetings both virtually and at conferences such as TODOS and the NCTM Research Conference.

Our long-term goal is to publish a special issue on ELs and mathematics. We hope to take the articles that are workshopped during Working Group 2019 and continue to work with participants to develop a full-fledged special issue. We currently plan to co-edit two special issues in two different journals: *TEEM (Teaching for Equity and Excellence in Mathematics)* and *Qualitative Studies in Education.* This work will be the culmination of four PME-NA working groups and can provide a product of the work from bringing individuals together who are committed to completing work around ELs and mathematics.

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