Impact on Teacher Beliefs about Emergent Bilinguals' Mathematical Learning

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We investigated how an online course designed for teachers to learn how to teach mathematics for emergent bilinguals influenced teachers' beliefs toward emergent bilinguals, especially in terms of culturally responsive mathematics teaching. Using qualitative pre- and post-surveys and the modified culturally responsive mathematics teaching framework, we examined 27 teachers' responses within five domains: cognitive demand, mathematical discourse, power and participation, academic language support, and funds of knowledge. The results showed both preservice and in-service teachers began to shift their beliefs from deficit to asset-based views.

Keywords: Teacher beliefs · emergent bilinguals · English language learners · mathematics teacher education · online learning

Introduction

According to the Association of Mathematics Teacher Educators' position statement for equity in mathematics (2015), equity is access to high-quality learning experiences, inclusion for all learners, and respectful engagement with others. However, in cases of Emergent Bilinguals[1] (EBs; García & Kleifgen, 2010), who are generally called English language learners (ELLs) in the United States, their language and cultural differences are often considered as obstacles to access academic learning. Moreover, many teacher preparation programs in the United States have yet to include specialised coursework focused on teaching culturally and linguistically diverse students (Education Commission of the State, 2019), and the specialised coursework is even less common in less ethnically diverse countries, such as South Korea (I et al., 2019).

Researchers have emphasised the importance of providing teachers with content-specific training to teach EBs (I, 2019; Vomvoridi-Ivanovic & Chval, 2014). Yet, many mathematics teachers have not received EB-specific pedagogical knowledge in their teacher preparation programs or received professional development in this area. Consequently, we designed and

[1] To align with a global context, we would like to use a general term, instead of ELL or EL, which is commonly used in the U.S. where the instructional language is English. Although there are other general terms to indicate students who do not yet have fluency of an instructional language, such as Additional Language Learners (ALL), we chose Emergent Bilinguals because it conveys an intellectual image of bilingualism and shines the linguistic asset that these students already have. Moreover, this term emphasises the educational goal for these students is not making them mere English speakers, but proficient bilinguals by sustaining their first language.

offered an online course about teaching mathematics to EBs for both preservice and in-service teachers, henceforth referred to as teachers. Using online courses to improve teachers' professional knowledge has been popular in the past two decades (Crockett, 2010), but little is known about the impact of an online course for teachers, especially focusing on mathematics and EBs. This developed online course is unique in that it focuses on the intersection of EBs, mathematics, and teaching, while other courses in teacher education generally focus on teaching EBs in non-content specific subjects or do not intentionally focus on EBs, but on teaching mathematics to a broad range of multicultural or underrepresented students. The goals of the online course are developing and refining teachers' appreciation for and understanding of EBs, and deepening teachers' pedagogical content knowledge on research-based instructional practices for teaching mathematics to EBs.

We were particularly interested in how this mathematics-specific and EB-focused online course influences teachers' beliefs about EBs and instructional teaching practices for EBs. We argue the instructional design of this online course may shed light to equip teachers with knowledge and inclusive perspectives of teaching mathematics to EBs as well as provide essential knowledge to teacher educators regarding EB-specific courses. Hence, we investigated the following research question:

> How do preservice and in-service teachers' beliefs on teaching mathematics for EBs change after participating in an EB-specific online course?

In addition, we examined emerging differences between preservice and in-service teachers' responses.

Literature Review

Many teacher preparation programs in the country where the participants of this study reside have not adequately prepared future teachers to teach EBs (Cochran-Smith et al., 2016). In this section, we describe how previous research has addressed the inadequate teacher preparation for teaching EBs and provided recommendations for teaching EBs and how prior research addressed teacher beliefs related to teaching mathematics for EBs.

Teaching Emergent Bilinguals

Exclusionary tracking (i.e., EBs are excluded from core academic content area classes) which limits EBs' learning opportunities in mathematics course taking (Umansky, 2016), coupled with the shortage of teachers who have pedagogical knowledge for EBs, are believed to be the reasons for the limited access to high-quality content that EBs in the United States widely experience. Currently, limited studies exist related to PSTs' learning about teaching mathematics for EBs and there are fewer studies about in-service teachers within the same topic. de Araujo, Roberts, Willey, and Zahner (2018) identified only 12 articles (7 for PSTs and 5 for in-service teachers) related to teacher education and EBs. Despite the small number, there have been some positive results such as Chval (2004) and Siwatu (2007). Chval (2004) found that PSTs made stronger cultural connections when they had repeated teaching of the same lesson to a small group of students, conducted task-based interviews with EBs, and conducted the same interview with several children. Similarly, Siwatu's (2007) survey revealed that the PSTs in the study were more efficacious to help EBs value themselves as important members of the class and to develop a positive relationship with their students than to communicate effectively with EBs.

In addition to these research studies, there have been several recommendations to guide teacher educators and professional development providers in the effective ways to prepare in-service teachers to teach EBs. Moschkovich (2012) emphasised that teachers of EBs should follow general recommendations for high-quality mathematics instruction, such as promoting conceptual understanding and allowing students to experience productive struggles. To provide EBs with access to high-quality mathematics, it is essential to have a view of (first) language as a resource and asset, not a deficiency, and pursuing academic achievement, not only English mastery (Gándara & Contreras, 2009; Moschkovich, 2010). With these general guidelines, there have been practical recommendations for teaching EBs high-quality mathematics, such as providing challenging tasks (Celedón-Pattichis & Ramirez, 2012), using rich mathematical discourse (Barwell, 2020; Khisty & Chval, 2002), encouraging participation through metalanguage interactions (Takeuchi, 2015), allowing students use of multiple languages/translanguaging (Clarkson, 2006; Planas, 2014), and integrating students' home culture (I et al., in press). Particularly, Celedón-Pattichis and Ramirez (2012) emphasised EBs must be given mathematically challenging tasks regardless of their English proficiency level. Difficulties are manifested when teachers are not aware of students' cultural background, making it impossible to incorporate students' cultures in the learning of mathematics, which represents a problem internationally (Averill et al., 2015). Regarding EBs, Nieto (2009) emphasises the role of language in classrooms where including learners' home languages increases EBs' participation in class discussions. A student's home language and home culture developed historically over time represent an individual's funds of knowledge (González et al., 2006). Funds of knowledge in the learning of mathematics has a rich history impacting how mathematics is learned in the classroom (e.g., Aguirre et al., 2013; Civil, 1994; 2007; 2014; Turner & Drake, 2016).

Recently, there have been efforts to address culture with respect to teaching EBs. For example, Ahn et al. (2015) used culturally relevant pedagogy (Ladson-Billings, 1995, 2009) as a lens to observe mathematics classrooms of EBs in the United States and Japan, and I et al. (2019) employed culturally responsive mathematics teaching (Aguirre & Zavala, 2013) to analyse Korean elementary teachers' instruction for EBs in South Korea. Culturally relevant pedagogy and culturally responsive teaching (Gay, 2010; Villegas & Lucas, 2002) focuses on teachers' high expectations and integrating students' cultural aspects into classroom instruction. In sum, culturally relevant pedagogy involves three components: "(a) a focus on student learning, (b) developing students' cultural competence, and (c) supporting their critical consciousness" (Ladson-Billings, 2017, p. 142). Teachers who are culturally responsive value and respect each student's different cultural and linguistic background. Hunter et al.'s (2019) study on indigenous students in New Zealand found that when teachers use students' social and cultural backgrounds, language, and values, the students have more opportunities to engage in tasks with high-level cognitive demands. Culturally sustaining pedagogy (CSP; Paris, 2012; Paris & Alim, 2017) shares a similar view to culturally relevant pedagogy but emphasises the importance of retaining the heritage languages and cultures of multilingual/multicultural students, especially marginalised groups as stating, "CSP seeks to perpetuate and foster—to sustain—linguistic, literate, and cultural pluralism as part of schooling for positive social transformation" (Alim & Paris, 2017, p. 1). In these views, the impact of equity, culture, and language in mathematics education are deeply considered because students' home culture and language are used as resources for mathematical instruction (Moschkovich, 2010). These views, focusing on culturally relevant and sustaining pedagogies, are also well aligned with the guiding principle of teaching EBs—*viewing language as a resource and asset, not a deficiency*—mentioned above.

This is in contrast to deficit thinking. Valencia (2010) describes deficit thinking as an internal explanation for the academic failure of low socio-economic status students of colour and explains that deficit thinking assumes internal deficits are the cause of any academic failure. Deficit thinking ignores a critique of structural oppression and indirectly blames and views marginalised students as the problem instead of using an asset-based framing that honours both the household culture and potential of all students (Yosso, 2005). Hence, it is crucial that teachers of EBs identify the existing deficit views and are aware of that how the deficit views can influence EBs' academic performance.

Teacher Beliefs about Emergent Bilinguals

Teachers' beliefs about students in the mathematics classroom significantly influences instruction (Barlow & Cates, 2006; Cross, 2009; de Araujo, 2017; Jackson & Delaney, 2017; 2020), which impacts students' learning (e.g., Durgunoglu & Hughes, 2010; Gutiérrez, 2002). While a universal definition of beliefs does not exist, Philipp (2007) defines beliefs as "psychologically held understandings, premised, or propositions about the world that are thought to be true…beliefs might be thought of lenses that affect one's view of some aspect of the world or as dispositions toward action" (p. 259). Similarly, Cross (2009) contends beliefs are "embodied conscious and unconscious ideas and thoughts about oneself, the world, and one's position in it, developed through membership in various social groups" (p. 326). For example, McLeman and Fernandes (2012) found that bi/multi-lingual preservice teachers (PSTs) had more positive beliefs that EBs' culture does not negatively influence their mathematics learning when compared to monolinguals. Therefore, personal membership in a particular social group can influence PSTs' beliefs about EBs in teaching and learning of mathematics. In this study, we draw on Cross's definition of beliefs to examine teachers' beliefs towards EBs in the mathematics classroom.

Teachers' beliefs toward EBs have been construed as productive and unproductive beliefs. Productive beliefs or asset-based beliefs honor both the household culture and potential of all students, whereas deficit-based beliefs or unproductive beliefs devalue marginalised students' culture, language, and the ways of being themselves (Yosso, 2005). It is crucial that teachers of EBs identify their existing unproductive beliefs and acknowledge how these deficit-based beliefs influence EBs' academic performance. Moschkovich (2016) found that the PSTs in her study held the following *naïve beliefs* (i.e., unproductive beliefs) about EBs: (1) EBs cannot participate in mathematical discussions, (2) Everyday/home languages are obstacles to doing and learning mathematics, and (3) Mathematical discourse requires formal vocabulary to express mathematical ideas. Similarly, Fernandes (2020) argued PSTs had a pervasive unproductive belief about EBs using their native language in mathematics classes. Fernandes used the Mathematics Education of English Learners Scale (Fernandes & McLeman, 2012) to survey PSTs' beliefs about teaching mathematics to EBs. Of the 31 PSTs participating in the survey, two contended that EBs' native languages should not be used in the mathematics classroom. In fact, these beliefs could have deleterious effects on the EBs' education because they deny the EBs' part of cultural roots and identities. Moreover, about 48% of the PSTs in the study shared that EBs' use of their native language should be limited in the mathematics classroom. The PSTs were concerned that allowing EBs to use their native language would hamper their interest and motivation to learn English. Thus, they believed it was necessary that the majority of the EBs' interactions should be conducted in English so that the EBs would be immersed in the English language.

In previous research, researchers found that many PSTs have unproductive, deficit-based beliefs toward EBs in the teaching and learning of mathematics (e.g., McLeman, Fernandes, & McNulty, 2012; Reeves, 2004). Chval and Pinnow (2010) identified three unproductive beliefs PSTs have toward teaching EBs: (1) that EBs should receive differential treatment based on their country of origin; (2) that EBs should be isolated rather than integrated into the learning community, and (3) the needs of the EBs should be outsourced rather be the responsibility of all teachers. The unproductive beliefs often lead teachers to have deficit views about EBs. For example, that EBs' culture and language are deficient, that a difference in culture and language cause difficulties in learning, that EBs' parents and communities do not support EBs' schooling, and that EBs are unable to meet grade-level learning goals (Flores et al., 1991; Pettit, 2011). This study addresses the gap in the literature about effective preparation for teachers of EBs in both language and culture, highlighting how teachers can shift their beliefs towards asset-based views on EBs.

Conceptual Framework

In order to examine the influence of an online course on teachers' beliefs toward EBs, we drew on Aguirre and Zavala's (2013) Culturally Responsive Mathematics Teaching (CRMT) framework. The CRMT is grounded in culturally relevant pedagogy (Ladson-Billings, 2009), culturally responsive teaching (Villegas & Lucas, 2002), pedagogical content knowledge (Shulman, 1986), and the work of the Wisconsin Center for Educational Research and the Center for the Mathematics Education of Latinos/as (Wisconsin Center for Educational Research, 1992). The CRMT framework, originally designed for lesson analysis, consists of eight dimensions that inclusively addresses the categories of mathematical thinking, language, culture, and social justice:

1. Intellectual support,
2. Depth of student knowledge and understanding,
3. Mathematical analysis,
4. Mathematical discourse and communication,
5. Student engagement,

6a. Academic language support for EBs,
6b. Scaffolding strategies,

7. Funds of knowledge/culture/community support, and
8. Critical knowledge/social justice.

"Categories 1–5 were drawn from a classroom observation protocol developed at the Wisconsin Center for Educational Research" (Aguirre & Zavala, p. 168) and Categories 6–8 were added to explicitly address different dimensions of CRMT outlined in the literature that focus on language, culture, and social justice. The language categories (6a and 6b) were modified from an all-encompassing academic language support for ELL[EB] category that was developed by the Center for Mathematics Education of Latinos/Latinas (p. 170).

For this study, we adapted the CRMT framework to include five domains: cognitive demand, mathematical discourse, power and participation, academic language, and cultural/community-based funds of knowledge (see Table 1). This adaptation allowed us to focus more on teachers' beliefs about EBs rather than on lesson analysis. We intentionally used the modified framework for survey development and as a lens to analyse the survey data. For this reason, we simplified and merged the eight categories to eliminate the components that were not possible to answer without actual lesson observations. The surveys in this study asked about teacher beliefs with respect to teaching EBs mathematics, thus each domain was reframed in terms of EBs. Table 1 describes what we measured in each domain and examples of teacher action for EBs within each domain.

Table 1:
Five Domains of Modified CRMT Tool Adapted from Aguirre and Zavala (2013)

Domain	Description	Example teacher beliefs related to EBs
Cognitive Demand	A lesson enables students to explore/analyse math concepts, procedures, and reasoning strategies and think in depth.	Teachers believe EBs are capable of doing quality mathematics and provide challenging math tasks.
Mathematical Discourse	A lesson creates opportunities to discuss mathematics in meaningful and rigorous ways	Teachers believe EBs can participate a meaningful mathematical discussion if they are provided with proper support.
Power and Participation	A lesson distributes math knowledge authority, values student math contributions, and addresses status differences among students.	Teachers believe it is crucial to value EBs' contribution to group work or class discussion.
Academic Language Support	A lesson provides academic language support for EBs.	Teachers believe EBs can learn mathematical language with appropriate support such as L1, visuals, gestures, objects, etc.
Cultural/Community-based funds of knowledge	A lesson helps students connect mathematics with relevant/authentic situations in their lives and use mathematics to understand, critique, and change an equity or social justice issue in their lives.	Teachers believe valuing and integrating EBs' cultural experience into math lesson is important and essential.

Methods

In this section, we provide detailed information of the research design, including the online course content, participants, data collection, and analysis methods as well as the development process of the survey and the main instrument of this research study.

Online Course Structure

Using *Canvas* (www.canvas.net) as a platform, we developed an online course curriculum consisting of six modules of essential topics for teaching mathematics for EBs for K-12 in-service and PSTs:

1. Who are EBs?,
2. Culturally responsive teaching,
3. EB-focused strategies,
4. Academic language,

5. Mathematical discussion, and
6. EB-focused lesson planning.

In addition to these modules, we included an introductory module and a final group project module (see Table 2 for description of modules). The course was designed for preservice and in-service teachers but was also open to other educational entities, such as instructional coaches, administrators, ESL/ELL teachers and teacher educators (college professors). All PSTs enrolled in the online course for 3 credit hours, whereas the in-service teachers had an option to take the course for 1, 2, or 3 credit hours.

In each module, the teachers read articles, watched interactive videos with embedded guiding questions, which allowed teachers to answer questions while watching the video, participated in discussion forums, and completed an exit assignment—called Investigation. The reading assignments were from the main textbook, *Beyond Good Teaching* (Celedón-Pattichis & Ramirez, 2012), and EB-related articles from practitioner and research journals. The videos within each module explained each module's essential topics and were approximately 10-minutes. Each module had two discussion board forums with a prompt to facilitate and encourage conversation amongst teachers. The first discussion forum prompted the teachers to discuss their learning from the readings and videos, and the second prompt was module specific to assess the teachers' understanding of the topic. Finally, the investigations provided an opportunity for the teachers to apply what they learned in each module. The teachers were given a choice of completing the investigation in an actual classroom. The option of with or without classroom access allowed the teachers to select which investigation best reflected their experience. In Table 2, we provide the details of each investigation assignment for the classroom access option.

Table 2:
Descriptions and Main Assignments of the 7 Modules

Module	Description	Investigation
0	Introduction of the course goals, system, and how to use Canvas	Develop a mathematical representation (e.g., map, graph, diagram, etc.) of the enrolled students' information they shared online
1	Who are EBs? Definition of EBs and challenges EBs have in mathematics class	Watch a film, Immersion, at http://www.immersionfilm.com/ with your students/others and discuss/write about your learning
2	Culturally Responsive Teaching	Analyse your lesson plan (or recall a lesson taught) using the CRMT framework
3	EB-focused strategies to teaching mathematics for elementary/secondary students	Modify a 3-act task for EBs, use it in your classroom, and write a reflective summary of the lesson
4	What is academic language and how to support EBs to learn academic language	Choose a word problem from your textbook/curriculum and analyse it using the framework in *Beyond Good Teaching*. Write a reflection on how it would help (or helped) you teach word problems to EBs.
5	How to support EBs to participate in meaningful mathematical discussions	Prepare a discussion plan to be implemented in your mathematics class, including at least three strategies or tools to facilitate EBs language use during the discussion. Record (video or audio) the discussion and write a reflection
6	Understand an EB-focused lesson plan	Analyse a Sheltered Instruction Observation Protocol (SIOP) Model (Echevarria et al., 2010) lesson plan using what you learned in this course

After the teachers completed all six modules, they were asked to develop, implement, and revise a lesson plan as a final group project using at least three EB-focused strategies and a 4-column lesson plan template (Matthews et al., 2009) in which one column focused on each of the following: teacher steps, anticipating students' actions, teacher actions to address students' actions, and formative assessment. This lesson plan format was purposefully selected so the teachers would include and consider students' understandings and misunderstandings.

Participants

Among the 129 teachers enrolled in the online course, 27 teachers consented to participate in the study. All 27 participants were educators in the United States, and 18 of them were PSTs who were enrolled in a University-based teacher preparation program, and nine were in-service teachers. The PSTs consisted of elementary education majors pursuing a K-8 mathematics endorsement
(n = 17) and a secondary mathematics major (n = 1). The PSTs had previously enrolled in

mathematics content courses (e.g., discrete mathematics), general pedagogy courses (e.g., educational psychology, social justice in education), and at least one course of mathematics pedagogy (elementary or secondary). The in-service teachers consisted of one elementary teacher, two middle school mathematics teachers, one high school algebra teacher, three mathematics interventionists/consultants (2 elementary and 1 middle), one ELL consultant, and one former high school mathematics teacher.

Data Source

We developed an open-ended survey based on the adapted CRMT framework. Hence, we designed questions specifically related to the five domains (see Table 3). The name of each domain was not visible to the teachers. The teachers took the survey at the beginning and end of the online course. The survey at the beginning of the course included additional background questions (such as their native language and teaching experience), and the post survey included questions asking for feedback on the online course. The survey consisted of fourteen questions each aligned to one of the five domains from the CRMT framework.

Table 3
Survey Instrument

Domain	Purpose	Sample Question
Cognitive Demand	To examine how teachers believe EBs should be given challenging tasks and engage in critical thinking in a mathematics class.	Explain your thinking about the following statement: "It is important for EBs to learn basic English language skills before engaging in critical thinking, such as problem solving."
Mathematical Discourse	To examine in what way teachers believe they can support EBs to discuss mathematics.	What group configuration (e.g., whole class, individual, pair, group of the same language speakers, or group of native English speakers, etc.) do you think best serves EBs? Explain.
Power and Participation	To examine how teachers identify the power dynamic surrounding EBs and respect cultural differences	How do teachers incorporate respect of each student's culture and identity in their instruction?
Academic Language Support	To examine what strategies teachers believe are effective to help develop EBs' English proficiency	How do you think teachers can help EBs develop their English proficiency in mathematics? Explain your ideas.
Funds of Knowledge	To examine how teachers believe they should incorporate EBs' funds of knowledge	Do you think teachers should have EBs share their home culture with the entire class? Explain why or why not.

Data Analysis

We descriptively and qualitatively analysed and compared the data through two phases. Prior to the first phase, we reviewed our survey instrument (Table 3) with participants' responses to pre- and post-surveys to ensure each item aligned with the corresponding domain. We noticed there were mismatches between some items on the pre- and post-surveys. We decided to exclude those items due to the misalignment between pre- and post-survey items, which inhibited us to compare the responses or measure the changes. Consequently, each domain resulted in one to three survey items that showed sufficient alignment for us to compare and analyse the changes. In phase one, three coders (the authors) independently open coded any change between the participants' responses on the selected items on the pre- and post-surveys. After multiple discussions, we agreed on four codes: major change, minor change, no change, and unrelated. Details of each code are in Table 4.

Table 4
Coding Manual

Code	Description	Example
Major change	The response on the post survey clearly show a different perspective from the pre-survey	The pre-survey response was "Disagree," but the post-survey response was "Agree."
Minor change	The response on the post survey has a similar overall stance, but the details are different from the pre-survey response.	The post-survey response had the same agreement or disagreement from the pre-survey but showed a deeper understanding or include more detailed strategies in the explanations.
No change	The responses on the pre- and post-surveys do not show a significant difference.	The pre-survey response mentioned visuals and word wall as effective ELL strategies and the post-survey response also included only these two strategies.
Unrelated	The responses on the pre- and post-surveys do not include any related information, so not possible to compare or identify a change between them.	The pre-survey response included two strategies for EBs and the post-survey response also included two strategies, but totally different from the two strategies on the pre-survey

Employing the content analysis method (Bernard & Ryan, 2009), we calculated the frequency of observed codes for each item, then combined the frequencies of each code in all items of each domain. Then, we compared the frequencies of each code to the total number of all codes in the same domain to find percentages for each code in each domain. We continued to discuss the coding until there was more than 80% agreement on each item to examine what changes were made in each code. After finalising the codes, the second phase of data analysis began. In phase two of the data analysis, we employed thematic analysis (Saldaña, 2015) to find emerging themes within each item and domain, such as major/minor changes were made when a change from deficit view to asset view or vice versa, or no changes were made in a consistent positive view or a consistent negative view. We wrote analytic memos for deeper analysis within the patterns of major changes, minor changes, and no change within each domain. The combined analysis of phase one and phase two helped us identify specific patterns about what types of changes were evident from pre to post.

Results

We first describe the overall patterns of change in the responses on the surveys, and then we discuss the changes within each domain. Table 5 shows the observed frequencies by domain.

Table 5
Observed changes by Domain

Domain	Unrelated	No Change	Minor Change	Major Change
Cognitive Demand (2)	9	12	21	12
Mathematical Discourse (1)	0	16	6	5
Power and Participation (2)	10	15	13	14
Academic Language Support (2)	12	23	15	4
Funds of Knowledge (3)	12	36	24	9
Total	43	102	79	44

Note: The numbers in parentheses indicate the number of survey items in the domain. Two teachers did not respond on one post-survey item in Power and Participation.

Overall Patterns

Each of the five domains showed a different pattern in terms of change in teachers' beliefs about teaching EBs mathematics (Figure 1). While one domain, Mathematical Discourse, did not have any unrelated changes, all other domains show a spectrum from major and minor changes to no change and unrelated. Combining major and minor changes, the changes in two domains (Power & Participation and Cognitive Demand) exceeded 50%, meaning more than half of the teachers enrolled in the online course changed their beliefs about teaching mathematics for EBs.

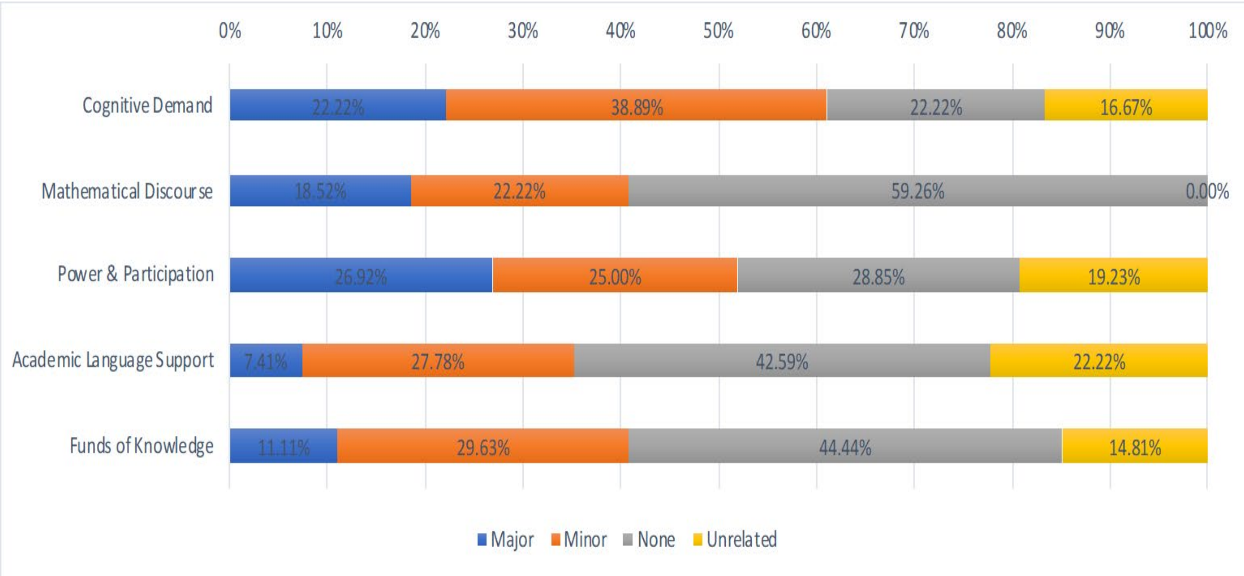

Figure 1: Results of Changes in Five Domains from Both Preservice and In-service Teachers

Among the five domains, Cognitive Demand showed the largest change (61.11%), while Power and Participation had the highest percentage of major changes (26.92%). The Academic Language Support domain had the lowest percentage of change among all domains. However, when the responses were separated into the teacher subgroups (i.e., preservice and in-service), we found that the result yielded a different pattern (see Figures 2 and 3).

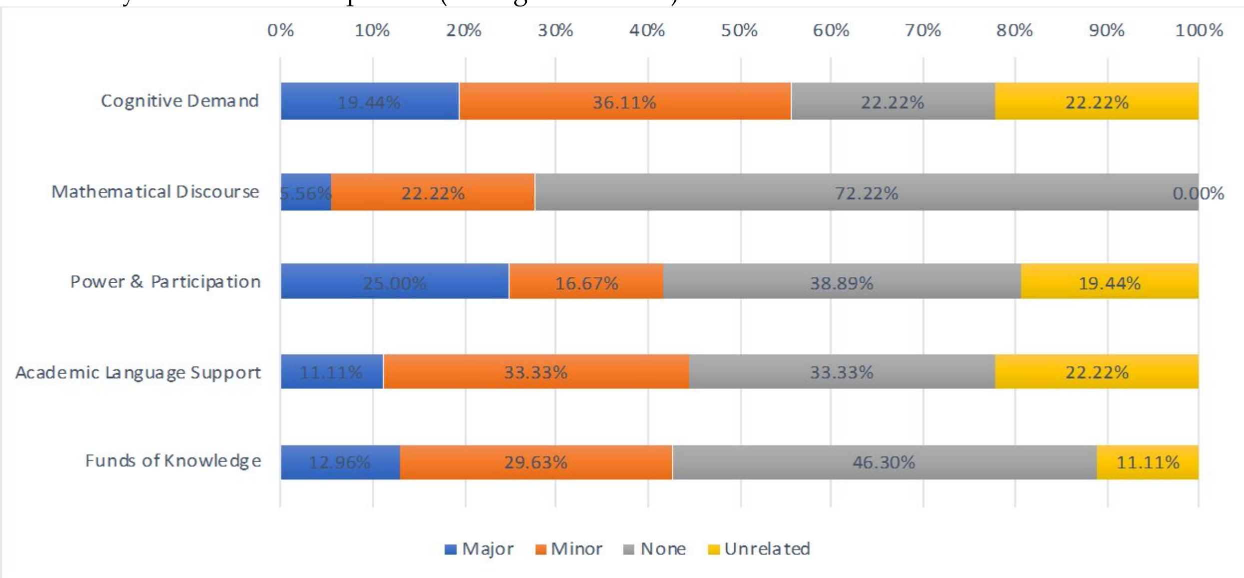

Figure 2: Changes in Preservice Teacher Beliefs by Domains

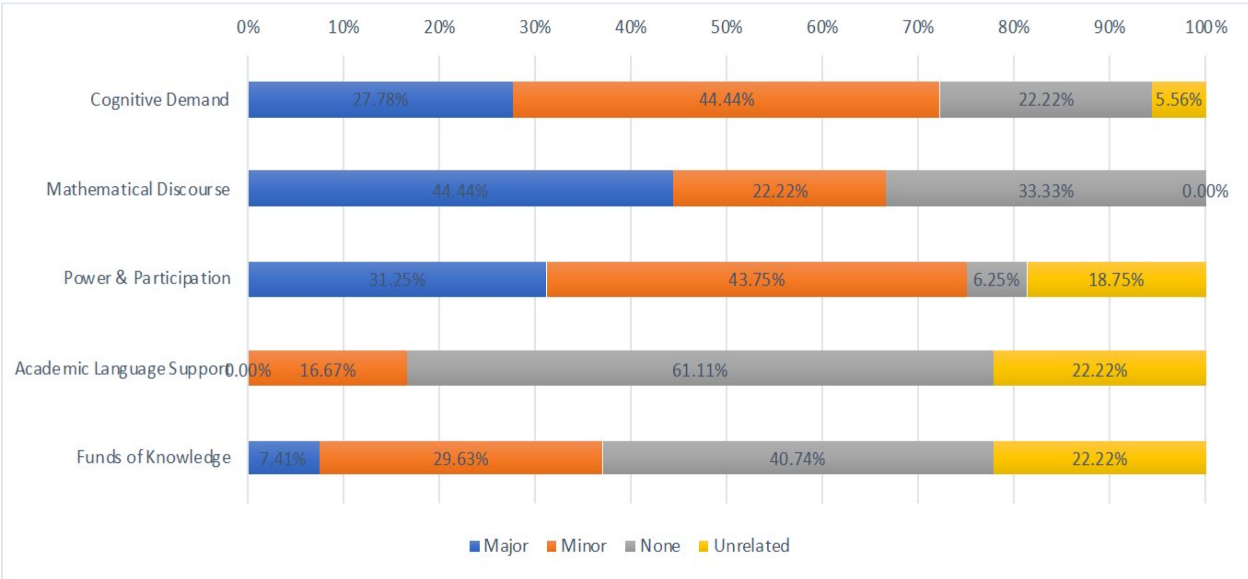

Figure 3: Changes in In-service Teacher Beliefs by Domains

While PSTs had the largest shift (combining major and minor changes) in their beliefs in the Cognitive Demand domain (55.56%), in-service teachers showed the highest rate of change in the Power and Participation domain (75%), although the Cognitive Demand domain also had a high rate of change (72.22%). When we used only major changes, Mathematical Discourse was the domain with the highest percentage (44.44%) of changes within in-service teachers while Power and Participation was the domain of the highest percentage (25%) of changes for PSTs. Interestingly, the Mathematical Discourse domain had the lowest percentage (5.56%) of major changes among all domains in PSTs' responses while the Academic Language Support domain had no major changes in in-service teachers' responses. Detailed interpretation of the results within each domain follows.

Within Domain Analysis

Domain 1: Cognitive Demand

In this domain, we found a significant change in awareness of EBs' capability to learn mathematics and language concurrently. The first item, *explain your thinking about the following statement: It is important for EBs to learn basic English language skills before engaging in critical thinking, such as problem solving,* addressed the pervasive misconception that EBs cannot learn challenging mathematics due to their language barriers. The item sounds general, but we aimed to examine at what cognitive demand level (Stein et al., 2009) the teachers were willing to provide mathematical tasks or activities because teachers may reduce cognitive demand when teaching EBs by offering too much help or making the work too easy (i.e. below grade level). The key term in this statement was "before" because requiring EBs to become fluent in English *before* learning their grade-level mathematics prevents EBs from having equal opportunity to learn mathematics. When their English fluency finally meets the required level, they are likely to be behind in mathematical learning or placed in a low-level mathematics track (Umansky, 2016). In the pre-survey, 48% teachers stated learning English is important because it is required to learn high-level mathematics. Although communication is counted as important or essential in problem solving or other critical thinking activities, there were some limited assumptions that EBs may have difficulty with communication and did not think of alternative ways to communicate. There were also a few teachers (n = 3) who acknowledged that EBs can engage in critical thinking in their own language. However, the most common responses in the pre-survey showed mixed opinions: EBs can do problem solving, but communication would be difficult. Similarly, EBs can do problem solving, but it would be easier or better if they know basic English. A higher percentage of PSTs showed this limited view than in-service teachers. In the post-survey, many teachers (n = 7) still believed learning basic English was important, but there was more awareness about ways to help EBs engage in problem solving without knowing basic English. For example, one PST responded,

> Yes, it is helpful for ELL[EB] students to learn basic English skills, however I would not say it is critical. When students engage in problem solving it depends on the way the problem is presented. As long as it is still accessible for ELL[EB] students, they can succeed.

There was no comment about problems with communication on the post-survey responses, probably because they learned about various ways to communicate and express mathematical ideas through the course. For example, one PST responded on the post-survey,

> In order to engage in critical thinking, students need to be able to interpret discussions and communicate their thinking. This could be through talk, visuals, body language, etc.

For the second item, *In what ways would you support EBs to effectively learn mathematics?*, various strategies were mentioned on both pre- and post-survey responses. On the pre-survey, the teachers suggested strategies that may reduce cognitive demand of mathematical tasks such as using simple words or simply listed strategies without providing detailed rationales. On the post survey, the range of suggested strategies increased and several new strategies were discussed, such as the use of a challenging task, connecting to student's life experiences, writing keywords on the board, and setting language learning goals, which had all been addressed during the course.

Overall, this domain showed the most change among all domains with 61.11% combining both major and minor changes. This result also indicates that many teachers had held the unproductive belief (e.g., EBs cannot learn challenging mathematics before obtaining English proficiency) before they took this course and shifted their beliefs to understanding that teachers need to provide cognitively demanding mathematical tasks to EBs and believing that EBs are capable of doing challenging mathematics, such as problem solving without having first obtained English proficiency.

Domain 2: Mathematical Discourse

In this domain, in-service teachers shifted towards higher expectations of EBs and richer strategies while PSTs maintained their asset view. There was one survey item under this domain, *What group configuration do you think best serve EBs? Explain*. While the minor change (22.2%) was the same for both in-service and PSTs, in-service teachers' major change (44.44%) was significantly higher than that of PSTs (5.56%). We found the PSTs did not show much change because their responses on the pre-survey were rich and closely aligned with the course curriculum and objectives. This, in part, may be due to the PSTs' education program because mathematical discourse, one of the eight effective mathematics teaching practice (National Council of Teachers of Mathematics, 2014), was a central topic in the recent teacher education program in the United States. However, for many in-service teachers, mathematical discourse was relatively new. It is interesting to note that even though the PSTs previously learned about mathematical discourse in their teacher preparation programs, they did not focus explicitly on mathematical discourse with EBs. Thus, it is noteworthy that the PSTs were able to make the connections of mathematical discourse with EBs. For example, one PST commented on the pre-survey "I think a mix of group configurations. Provide opportunities for the ELL[EB] students to speak more often in a small group, and listen to others in larger groups." While on the post survey the same PST stated, "A combination of groupings. It is best for ELL[EB] students to experience opportunities to listen, read, write, and speak during activities. Switching up groupings allows for this." While the PST acknowledged the importance of various group configurations for EBs in the pre-survey, their post-survey response focused more on the importance of listening, reading, and writing for EBs. In contrast, one of the in-service teachers' pre-survey responses stated,

I'm not sure. I typically place them together at a table. That way they can help each other if I can't right away. There are usually a couple English speakers too, but from observation, the interaction is pretty low between the groups.

On the post-survey, the in-service teacher provided a more structured and focused response, "I think the start of the year put same language speakers together. Then throughout the year integrated them into the regular groups."

Domain 3: power and participation

In this domain, in-service teachers' change was noteworthy. They voiced about caring EBs' culture, identity, and well-being in classrooms in their responses on the post-survey. For the first item in this domain, *How do teachers incorporate respect of each student's culture and identity in their instruction?,* the pre-survey responses suggested including EBs' culture and identity within classroom decor (e.g., posters), books, and class celebrations with food, games, guest speakers from "celebrated" culture. On the post survey, the responses ranged from ensuring EBs felt comfortable sharing about their cultural identity to getting to know the students and their backgrounds to using students' funds of knowledge in designing the lesson. One in-service teacher's response summarises the responses of all the teachers,

It is important that classroom policies and guidelines are clear and set at the very beginning of the academic year to make sure there is respect in the classroom. As teachers, we must reach out to students in ways that are culturally and linguistically responsive and appropriate. We must examine the cultural assumptions and stereotypes we bring into the classroom that may hinder interconnectedness. Looking closely at this can help teachers think about how to deal with uncomfortable situations. If a student is being disrespectful, having a conversation with the student (and parent is situation escalates) can also help. It is crucial that all students understand where they come from and how [I] can use their background as a valuable asset.

For the second item, *Explain to what extent you agree or disagree: When teachers find an EB who is not welcomed to join group activities by her/his peers, teachers should immediately intervene*, many teachers did not readily choose between agreement and disagreement. The most common responses were "it depends on the situation," "I would intervene but not immediately," and "I would wait until students resolve the situation." From the responses on the pre-survey, it appeared many teachers were hesitant to intervene because they believed the intervention would make the situation worse. Instead, they believed it would be better if the students would handle the situation themselves. On the post-survey, some of the teachers changed their responses to either immediately intervening or building a safe environment early to prevent EBs from being bullied. However, several of the teachers still disagreed with the statement because they feared intervening may make the situation worse if students were forced to welcome other students.

Domain 4: Academic language support

We did not see many changes in this domain because the teachers already had positive responses on the pre-survey. The most frequent response on the first item, *It is more important for EBs to learn English than to maintain their first language. Explain why you agree or disagree,* was disagreement on both pre- (n = 20) and post-surveys (n = 19). It is possible several of the responses were attuned to sounding *politically correct*. A common response was that English and student's first language are equally important, so EBs should maintain their first language although learning English is important. Some teachers also mentioned identity. They regarded first language as part of EBs' (cultural) identity, and that was why teachers should support EBs to maintain their first language. One teacher commented, "students should be encouraged to continue learning their first language. Being able to speak more than one language allows more opportunity for the student in the future."

The response pattern on the second question, *How do you think teachers can help EBs develop their English proficiency in mathematics? Explain your ideas,*" appears to be similar to the second question in the Cognitive Demand domain (*In what ways would you support EBs to effectively learn mathematics?*). Unlike the question in the Cognitive Demand domain, the question in the Academic Language Support focused on how to *help* EBs learn English in mathematics classroom. Interestingly, the teachers did not notice the difference on the pre-survey as they provided similar responses to the items in both domains: help EBs understand language in solving mathematical problems rather than help them learn English in mathematics classes. Common responses included pictures, providing definitions, reading aloud, or using graphic organisers. These tools may help EBs learn English indirectly, but the teachers focused on vocabulary learning first, and thus there was no high-level linguistic activity such as writing or discussing. Some responses were about supporting EBs to understand mathematics and/or English rather than developing English proficiency. The post survey contained more in-depth responses, which included various strategies such as high demanding language activities. For example, one PST responded on the pre-survey, "Teachers can help ELL[EB] students develop their English proficiency in math by teaching them math vocabulary," while on the post-survey stated to "Allow students lots of time to discuss with their peers. This will allow the student exposure to the language. Although math should be the main focus during math time, it doesn't hurt to help ELLs [EBs] improve their English."

Domain 5: cultural/community-based funds of knowledge

While we found many positive changes in this domain, we also found some degree of resistance among teachers. On the first item, *Explain why you agree or disagree: Teachers who work with EBs in mathematics need special forms of knowledge and practice*; a third of the teachers changed their beliefs from pre to post with more awareness of EBs' unique needs. For example, one in-service teacher shifted from "I agree because they need to be able to have a dual lens: teaching both content and language" to the following response,

I believe teachers who work with ELs[EBs] in math need to use cultural and linguistic responsive instruction, be aware of the language levels of their Els[EBs], the cultural backgrounds, and also how to predict the language and content needs of their students. So yes, they do need to be prepared to teach ELs [EBs].

Even though both statements were agreement, the teacher was now looking at the cultural background and the individual language level of the learning. One PST on the pre-survey stated that special forms are not needed because mathematics is just content, thus it is the same for everyone. This same PST showed a major change on the post survey stating, "Math is not universal in all cultures; therefore, teachers need to be aware of the differences." By acknowledging that mathematics is not universal, the PST accepted multiple forms of mathematics. For example, the mathematics of each household reflects and embodies funds of knowledge. Despite these meaningful changes, 55.56% of teachers showed no change on this item. Basically, both PSTs and in-service teachers agreed teachers need training, and it is beneficial. Moreover, PSTs also valued teaching experience.

The responses on the second item, *Will you use EBs' culture when developing a mathematics lesson?,* were different between PSTs and in-service teachers while their combined responses were evenly divided into the four codes. Among the seven teachers who showed major changes, six were PSTs. Only one in-service teacher had no change, and a total of six PSTs did not change their beliefs on this item. One PST, who showed a major change stated on the pre-survey, "They need to make sure that it is an appropriate way of using the culture and isn't any way offensive," and on the post-survey responded, "I want to make sure all my students know that they come from different backgrounds and it is okay to understand that and learn from each other and learn what makes us each unique." This response showed a change on how the PST viewed culture in a complex manner. On the pre-survey, the teachers had a fear of cultural misrepresentation, the act of inaccurately associating an item/symbol to a culture. Yet, on the post-survey, we saw a framing of difference (different cultures) as being unique and valid. Teachers might fear committing cultural misrepresentations because they might worry that they were perpetuating stereotypes instead of showing accurate representations of a different culture. A PST on the post-survey responded,

Classrooms in the United States have become diverse over the last years. Making sure both teachers and students are mindful and respectful about what they do and say are crucial for effective student learning. Using EBs' culture when developing a mathematical lesson can better improve student learning if culture is incorporated appropriately.

Here we see the PST is aware of the need of understanding about how best to teach EBs with respect to the increased diversity of the United States. Overall, the pre-survey responses mentioned funds of knowledge will be beneficial to all students and should be incorporated in the class. On the post-survey, the responses tended to shift from the classroom to learning mathematics. We found that teachers who showed no change from pre- to post-surveys generally agreed that students' home culture should be used in making EBs more comfortable.

Finally, on the last question, *Explain why you will have EBs share their home culture with the entire class*, teachers were mostly positive about sharing students' culture on both pre- and post-surveys. On the pre-survey, the PSTs had a strong tendency of stating a condition, such as they would have EBs share their home cultures only if they feel comfortable. Similarly, four in-service teachers said "yes, but it depends on the students." Three of the teachers who said this type of statement changed to direct yes on the post. The opportunity to share "only if they feel comfortable" sentiment did not completely diminish as a few teachers still included the phrase on their post-survey. The post-survey responses focused on the positives of EBs sharing their home culture on the post-survey, "[it] helps the EBs share who they are with their peers and the other students can get to know who the new students are/where they come from." Another example of a positive change occurred when a PST who stated, "Yes, because then it allows for the EBs to feel included and give other students an inside look at different cultures. It can also help lessen stereotypes that some students may have or learn more about a tradition" on the pre-survey and responded on the post-survey, "it helps the EBs hold onto their culture, makes them feel welcomed, and opens the eyes of the other students. Even non-EBs come from different home cultures and we celebrate that so we shouldn't push that away from EBs." The PST maintained the positive notion of learning from EBs' home culture and expanding the idea of using home culture for all students, even in a course with non-EBs.

For the teachers who experienced a major or minor change in this domain, went from "it depends on the students" to "focusing on the positive." This change appeared across all the questions despite the remaining resistance. The change revealed that the teachers gained comfort and understanding of pedagogy needed to incorporate students' funds of knowledge within their instruction.

Discussion

The results from this study reveal the participating teachers' beliefs began to shift with respect to teaching mathematics for EBs after taking the online course. Teachers gained awareness of the barrier(s) that language creates and the need for access to rigorous mathematical tasks, which are beneficial to EBs. The results in the Funds of Knowledge and Power and Participation domains suggest us to consider a way to dismantle negative views/assumptions of EBs. Furthermore, both PSTs and in-service teachers begin to honour EBs, their languages and home culture. One of the findings was that in-service teachers had more dynamic changes than PSTs while both PSTs and in-service teachers showed positive changes in all domains. The domains that in-service teachers showed more positive changes than PSTs are Cognitive Demand, Mathematical Discourse, and Power and Participation.

The teachers started to shift from their deficit view and move towards an asset-based view (Moschkovich, 2010), and moved from not knowing to sociopolitical consciousness (Kokka, 2019) as a result of their learning in the online course. In addition, the results denote that the online course design may help teachers productively increase their awareness of EBs' possibility in the context of mathematical learning and grow their culturally responsive teaching standpoint. One clear gain among teachers appeared in the Cognitive Demand domain. Researchers recommend (e.g. Celedón-Pattichis & Ramirez, 2012; Chval & Chavez, 2011) teachers should see the importance of providing challenging mathematical tasks to EBs and maintaining high expectations (Hernandez et al., 2013; Villegas & Lucas, 2002). Moreover, learning strategies to teach mathematics to EBs through this course might influence this result because the teachers felt more equipped to engage EBs in quality mathematics.

However, we also found some resistance among teachers, especially when related to EBs' funds of knowledge. Although there was a strong tendency of valuing EBs' home culture, it appeared the teachers grounded it in a deficit perspective, which Moschkovich (2016) called naïve beliefs about EBs. A majority of teachers assumed that EBs are not comfortable to share their home culture because they have poor/low/unhappy/traumatic home cultures, not because teachers of EBs do not provide a safe place where EBs can share their culture with imperfect English. Although the teachers may not intend to devalue EBs' culture, this is concerning because their caring-deficit mindset may result in reducing or removing an opportunity for their non-EB peers to understand other cultures. Eventually, it may cause more difficulty building a culturally and linguistically safe environment in a classroom with EBs. This teacher perspective was pervasive on the pre-survey and remained on the post-survey, which is similar to Valencia's (2010) definition of deficit thinking that indicates a deficit view made teachers and students see only internal reasons (e.g., students' lack of knowledge in English or mathematics) of the academic failure, not structural oppression or lack of support. Similar to these research findings, the teachers in this study expressed their belief that the cause of EBs' uncomfortableness to share their home culture is EBs' internal deficits such as their traumatic memory and not external deficits such as lack of teacher support or an unwelcomed environment. Revisiting the idea of political correctness, teachers may not feel comfortable talking about home culture due to fear of cultural misinterpretations. If a teacher misrepresents a student's culture, it could in turn be viewed as the teacher is racist or classist. Hence, the importance of changing a teacher's belief lies over the mechanical use of an individual strategy.

Both culturally relevant pedagogy (Ladson-Billings, 2009) and culturally sustaining pedagogy (Paris, 2012) emphasise valuing students' diverse cultures. Furthermore, culturally sustaining pedagogy "asks us to reimagine schools as sites where diverse, heterogeneous practices are not only valued but sustained" (Alim & Paris, 2017, p. 3). When we consider how teacher beliefs influence instructional practices (Cross, 2009), it would be hard to expect the teachers who assume EBs' culture as something embarrassing will support them to sustain their culture. Opposed to many teachers' assumption, recent research studies (e.g., Lee & Walsh, 2017; I et al., in press) found how enthusiastic and excited EBs are when they are asked about their culture and language. For example, Lee and Walsh (2017) introduced a high school mathematics class where culturally sustaining pedagogy was applied where "students responded enthusiastically by sharing their knowledge" (p. 195) and cultural exchange. The teacher in this study expressed their beliefs of the importance of connecting students' experiences and cultures, including both historical and contemporary contexts of their home countries and provided opportunities to share student's home language and culture. Our results imply that agreeing with a general statement, respecting EBs' home culture, is not enough to completely change teachers' deficit views on EBs' culture. This is where our online course and future study need to further address and provide more pedagogical resources.

A limitation of this study is that some words on the survey might cause confusion or have multiple interpretations. For example, one of the items in the funds of knowledge domain, *Explain why you agree or disagree: Teachers who work with EBs in mathematics need special forms of knowledge and practice*, was intended to examine if the teachers were aware that EBs need more than just good teaching. However, the words "need" and "special" could be interpreted differently than we expected. Many teachers were hesitant about the word "need" and responded that training is beneficial but unsure if it is "needed." Similarly, the word "special" seemed to have different meanings for some teachers such as special education. Similarly, yet more seriously, the term, "home culture" might be interpreted as a private life; hence, many teachers said it depends on the comfort of the student.

Implications and Conclusion

This study provides meaningful information about how to use an online course for the purpose of developing teacher awareness of effective teaching and providing access to quality mathematics for EBs. We also found several merits of using this type of online course than face-to-face meeting with respect to providing an opportunity for teachers openly express their beliefs about EBs. First, a safer environment can be built without the power dynamic between PSTs and in-service teachers. Second, an asynchronous online space provides an equal stage and enough personal reflection time, so the students can prepare before they share their insights. In this environment, a few vocal people dominating the discussion does not happen. This environment may help teachers share their honest perspectives without political filtering. In this course, particularly, in discussion forums, teachers were not allowed to see other posts until they posted their entry, which provided them with opportunities to share more honest ideas and thoughts compared to viewing what everyone else thinks and making a similar post. Furthermore, we designed the course to involve classroom situations to make the assignments practical despite the online setting. Even if the teachers do not have classroom access, the assignments considered teaching real students (e.g., imagine you teach a 100% EB class), so teachers can instantly apply what they learned from the course.

The positive results of this study shed light on the possibility of using an online platform to equip teachers with asset-based beliefs and knowledge centered on equity. Considering the wider access of an online format, we believe our study can extend and magnify teachers' opportunities of learning and recognising the importance of a teaching paradigm of culturally sustaining pedagogy when teaching mathematics for EBs.

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