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Unpacking Preservice Teachers' Beliefs: A Look at Language and Culture in the Context of the Mathematics Education of English Learners

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We sought to understand the beliefs of preservice teachers (PSTs) regarding the mathematics education of English learners. Cluster analysis was used to determine a two-cluster solution from 330 survey responses. Since cluster analysis forms homogeneous groups, we analyzed the five items regarding culture, language, and teaching whose means did not differ significantly between clusters. Findings suggest that PSTs need targeted support in re-considering their perspectives about parental and family involvement in education. Findings also suggest that an increased knowledge in mathematical content has the potential to help PSTs see the interconnection of language mathematics, although mathematics teacher educators must make a deliberate effort to model the linguistic components inherent to mathematics.

Key words: preservice teachers, English learners, beliefs, mathematics

How do teachers learn about instructional practice? In particular, how do teachers learn about instructing populations of students when they do not share their students' linguistic backgrounds? In the United States, the population of students who speak a language other than English at home is rising. The National Center for Educational Statistics (NCES, 2009) reported that in 1980 this population of students accounted for about 10% of the total K-12 student population; in 2009, this percentage was more than double at about 21%. With this increasing number of English learners (ELs) in schools and a projected demand of more than 67,000 EL teachers by 2013, ELs require well-prepared teachers who are familiar with the unique challenges they face (Casteel & Ballantyne, 2010; Lucas & Grinberg, 2008). Yet, the NCES (2002) reported that only 12.5% of the 41% of teachers working with ELs are adequately prepared to provide the necessary support.

This lack of adequate preparation is felt at the teacher preparation level as well. To wit, less than one-third of teacher preparation programs required field experiences with ELs and only about 20% have a course that focuses on working with ELs (Casteel & Ballantyne, 2010). Preservice teachers (PSTs) have self-reported that they feel under-prepared to work with ELs (Durgunoğlu & Hughes, 2010). Additionally, texts for teacher preparation lack the content that specifically addresses the needs of EL students (Watson, Miller, Driver, Rutledge, & McAllister, 2005).

While there are a variety of studies that examine the beliefs of PSTs regarding the education of diverse populations of students (e.g. Pohan & Aguilar, 2001; Reeves, 2006; Tattoo, 1996), there is a dearth of ones that focus specifically on the beliefs of PSTs related to the mathematics education of ELs. Specifically, Janzen (2008) found no studies in mathematics education specifically targeting the EL population. We sought to understand the beliefs of PSTs regarding the mathematics education of ELs. A focus on the mathematics education of ELs is warranted as the percentage of ELs at all levels who performed below the basic achievement level on the National Assessment of Educational Progress mathematics exam in 2009 was at least double that of non-ELs (NCES, 2009). As such, we developed a survey instrument that measured PSTs' beliefs. In this paper, we examine instances where beliefs among participants showed no significant differences.

Theoretical Framework

According to Philipp (2007), beliefs are important to consider as they represent "psychologically held understandings, premises or propositions about the world that are thought to be true… Beliefs might be thought of as lenses that affect one's view of some aspect of the world or as dispositions towards action" (p. 259). For teachers, in particular, beliefs impact the knowledge they acquire since they will not assimilate practices they do not value (Philipp, 2007; Tattoo, 1996).

When it comes to EL students and their communities, deficit beliefs seem to prevail (e.g. Milner, 2005; Valdes, 2001; Walker, Shafer, & Liams, 2004). According to Moschkovich (2010), "deficit models stem from assumptions about learners and their communities based on race, ethnicity, SES (socio-economic status), and other characteristics assumed to be related in simple, and typically negative ways to cognition and learning in general" (p. 11). Deficit beliefs lead teachers to have lower expectations for EL students and, consequently, result in placement for ELs in special education classes (Donovan & Cross, 2002). Thus it is desirable that PSTs acquire, along with content knowledge, non-deficit perspectives that will guide their future work. Non-deficit models assume that EL students bring valuable resources, including their culture and language, to the classroom that teachers

can use to further build ELs' content knowledge (Civil, 2007; Moschkovich, 2010).

Beliefs about Culture

Many teachers hold deficit-based views of ELs' parent/family involvement in schools. Specifically, many assume that parents/families do not to care about their children's education because they do not attend school-wide events or do not initiate communication with teachers about their children's educational progress, among other things (Lareau, 1987; Souto-Manning & Swick, 2006). This paradigm, however, does not recognize diverse forms of parental involvement, such as parents sharing with their children how they learned to do mathematics in their home countries (Civil, Planas, & Quintos, 2005; Souto-Manning & Swick, 2006). To counter these deficit views, PSTs must be challenged to examine new paradigms that honor different cultural ways of knowing. Further, teacher preparation programs must promote the view that *all* parents/families are advocates for their children's education (Souto-Manning & Swick, 2006).

Teachers' deficit-based views are also manifested in their expectations for students. Research (Clair, 1995; Chval & Pinnow, 2010) has shown that teachers hold different expectations for students based on the language that the students speak. For example, Chval and Pinnow shared how elementary PSTs self-reported that they would teach mathematics to ELs differently based solely on their knowledge that the ELs came from two different countries with differing native languages. Thus, the PSTs' differentiation of expectations can be linked directly to the language spoken by ELs. If unchecked, such differences in expectations can and have translated into higher expectations for some cultural groups and lower expectations for others (e.g., August & Hakuta, 1997; Gandára & Contreras, 2009). In particular, the mathematics curriculum for ELs and other minority groups has historically focused a disproportionate amount of time on performing rote memorization instead of developing conceptual understandings (Gandára & Contreras, 2009; Oakes, 2005).

The Interconnection of Language and Mathematics

Many individuals view mathematics as devoid of language, and therefore assume that ELs should be placed in a mathematics class when first starting to learn English (Garrison & Mora, 1999; Walker, Ranney, & Fortune, 2005). This assumption is based on the belief that mathematics is precise and free from ambiguity (Barwell, 2005), a belief attributed to the symbolic nature of mathematics. Contrary to this assumption, there are numerous language demands that are inherent to the study of mathematics (Schleppegrell, 2007). For example, students in mathematics classes must

express themselves (both in writing and speech) through the formulation of conjectures and the justification of solutions, among other things (Barwell, 2005; Moschkovich, 2010). For ELs then, there is an added cognitive demand since they are learning mathematical concepts, the language of mathematics, and English simultaneously (Campbell et al., 2007; Garrison & Mora, 1999). Adding to this demand is that some of the words (such as *table*) that are learned through everyday occurrences have different meanings within the context of mathematics.

If no explicit efforts are made in teacher preparation courses to address linguistic diversity, it is possible that PSTs will believe that teaching ELs simply equates to good teaching that is applicable to all students (de Jong & Harper, 2005).What PSTs may fail to realize is that ELs who are proficient in everyday English may still need linguistic support to acquire the discipline specific language seen in the classroom (Cummins, 2000). Moreover, as Duff (2001) notes, even motivated ELs who have a strong support system and good study skills are challenged to master both the written and oral text associated with a specific discipline due to the fast-paced interactions that take place in mainstream classrooms.

Within the context of this study, we assumed that the language spoken by students is a valuable resource and the teachers should foster its use in the classroom context. Further we assumed that families from *all* communities are assumed to fundamentally care about the intellectual development of their children, even if it is of a form that is different than what is expected by the teacher.

Methods

Instrument

The survey consisted of 8 demographic items (e.g. gender, race, field experience) and 26 belief items. Each of the 26 items measured the strength of agreement or disagreement of a PST's belief using a 5-point Likert scale (from Strongly Disagree (1) to Strongly Agree (5)). The items for the survey were developed and refined by examining key constructs in the literature and personal experiences as mathematics educators. Content validity of the items was established by consulting 10 experts in the area; modifications and additions were made on the basis of their recommendations. Further, face validity was established through three questions at the end of the survey that determined the readability and clarity of the survey.

Data Collection

The authors recruited PSTs around the United States to participate in the study. Colleagues from around the United States were asked to distribute

an email invitation to their students. Overall 334 PSTs from 12 different states around the United States responded to an online survey that was hosted on SurveyShare.

Statistical Analysis

The data was downloaded and analyzed with SPSS 19. We scored the items based on our non-deficit perspectives described in the review above. Based on these perspectives, we reverse scored 14 items (indicated with an r after item number) where a score of 1 represented the most deficit response and a 5 represented the least deficit response. Since beliefs can only be inferred, we posited, for example, that PSTs would not be open to viewing an EL's culture as a resource in the classroom if they believed that it could negatively impact the EL's mathematical learning.

We determined the outliers using Mahalanobis distance and removed these from further analysis since they could distort the results (Aron & Aron, 1997; Stevens, 1992). Four outliers were determined ($p < 0.001$), thus 330 of the 334 responses were used for hierarchical cluster analysis. Specifically, we used Ward's method with the Euclidean squared distance. This analysis is useful in partitioning the responses into clusters that have high within-cluster homogeneity and high between-cluster heterogeneity (Hair & Black, 2000). Cluster analysis was appropriate for this data since the variance inflation factor yielded values closer to 1 and well below the cut-off of 10 (Stevens, 1992) indicating an absence of a high degree of multicollinearity.

Results

A two-cluster solution was confirmed on the PST responses to the 26 belief items. The number of clusters was determined by examining the distance between successive coefficients in the agglomeration table. Larger distances are indicative of the recombination of more non-homogeneous groups into one group at the next stage. For our survey, a distance of 741 between the last two coefficients and then a relatively stable distance of 254 and 219 for the next two pairs suggested a two-cluster solution. Observation of the dendogram also supported the two cluster solution. The two-cluster solution was validated by splitting the data into two equal sets and confirming the persistence of a two-cluster solution for the split data (Hair & Black, 2000).

Demographic information was used to profile the two clusters. A chi-square test ($p < 0.05$) was performed on each demographic variable to seek significant associations to cluster membership. Table 1 presents the number of participants who were in Cluster 1 (C1) and Cluster 2 (C2), broken down by demographic characteristics.

Table 1
Number of Respondents Per Demographic Variable

	Cluster 1 (C1) **251**	**Cluster 2 (C2)** **79**	**Total** **330**
Gender	Male: 24 Female: 227	Male: 22 Female: 57	Male: 46 Female: 284
Race	Hispanic: 7 African American:18 White: 213 Asian: 4 American Indian:1 Bi/Multiracial: 4 Other: 4 No response: 0	Hispanic: 3 African American:3 White: 67 Asian: 2 American Indian: 1 Bi/Multiracial: 2 Other: 0 No response: 1	Hispanic: 10 African American: 21 White: 280 Asian: 6 American Indian: 2 Bi/Multiracial: 6 Other: 4 No response:1
Teaching Interest	Grades K-5: 183 Grades 6-8: 43 Grades 9-12: 25	Grades K-5: 56 Grades 6-8: 14 Grades 9-10: 9	K-5: 239 Grades 6-8: 57 Grades 9-12: 34
Teaching Experience	None: 179 0-4 years: 67 5-10 years: 5	None: 57 0-4 years: 17 5-10 years: 5	None: 236 0-4 years: 84 5-10 years: 10
Field Experience	Yes: 198 No: 53	Yes: 55 No: 24	Yes: 253 No: 77
Exposure to ELL issues	Yes: 190 No: 61	Yes: 47 No: 32	Yes: 237 No: 93
Fluency in another language	Yes: 20 No: 231	Yes: 6 No: 73	Yes: 26 No: 304
Experience learning a second language	Yes: 217 No: 34	Yes: 63 No: 16	Yes: 280 No: 50

Of the 8 demographic variables, significant associations to membership in C1 were found for two demographic variables: gender (*chi-sq*=16.749, *df*=1, $p < 0.05$) and exposure to EL issues in prior coursework (*chi-sq*=7.795, *df*=1, $p < 0.05$). In other words, participants who were female and had exposure to EL issues in prior coursework were more likely to be in C1 than C2. The differences between the means of C1 and C2 for each of the 26 belief items were calculated, and a two-tailed independent samples *t*-test ($p <= 0.05$) on the mean scores with respect to each item was performed. Given cluster analysis forms homogeneous groups, we were particularly interested in those items whose means did not differ significantly between C1 and C2.

Within our two-cluster solution, we found five items where the means between C1 and C2 ($p < 0.05$) were not significant: ilm19r, dc23r, dc24r, tm29r, and tm33 (see table 2). Specifically these (paraphrased) items are:

- ilm19r: Math is ideal for beginning ELs to transition into learning English.
- dc23r: Some EL's home culture negatively impacts their math learning.
- dc24r: Parents from some cultures place a higher value on education than parents from other cultures.
- tm29r: To make the content clear to ELs, I would use limited math vocabulary.
- tm33: Creating discussion rich classrooms is necessary for ELs to learn math.

Table 2

Items, With Cluster Means, Which Were Not Significantly Different

	C1 mean	**C2 mean**	**Difference in means**
ilm19r	2.605577689	2.64556962	-0.04
dc23r	2.864541833	2.64556962	0.219
dc24r	1.844621514	2.050632911	-0.206
tm29r	3.637450199	3.392405063	0.245
tm33	3.996015936	3.848101266	0.148

Note: ilm=interconnection between language and mathematics; dc=diverse cultures; tm=teaching mathematics

We examined the five items with respect to each of the 8 demographics to uncover characteristics of the PSTs that may have influenced their perspectives. In all instances, we rounded up the percentages.

In dc23r, 50% of the students who were fluent in another language disagreed or strongly disagreed that home culture had a negative impact on mathematics learning as opposed to 23% of PSTs who were not fluent in another language. Of the 26 PSTs who were fluent in another language, 9 were White. A closer look at these 9 students revealed that 2 disagreed, 2 were undecided, and 5 agreed with the statement. Across ethnicities, 50% of

Asians, 30% of Hispanics, 29% of African-Americans and 24% of Whites disagreed or strongly disagreed with the statement.

For item dc24r, 70% of Hispanics (of 10 total), 81% of African-Americans (of 21 total), and 100% of Asians (of 6 total) agreed or strongly agreed that parents from some cultures placed a higher value on mathematics education. About 87% of White PSTs agreed or strongly agreed with the same statement. In consideration of experience in the classroom, 81% of those with prior experience in the classroom versus with 88% with no experience agreed or strongly agreed with the same statement, although 5 of out of 10 PSTs with 5-10 experience disagreed. Finally, examining the data across exposure to EL issues within their coursework, 85% of PSTs who had exposure agreed or strongly agreed with dc24r, compared to 61% of PSTs who did not have such exposure.

For ilm19r, 55% of females (compared to 43% males), 70% of Hispanics and 83% of Asians believed that compared to other subjects, mathematics was ideal for transitioning beginning ELs to learning English. Among Whites and African-Americans, approximately 53% and 48% felt the same way, respectively. When partitioning the data by teaching interest, approximately 44% of PSTs interested in teaching high school, compared to about 54% each of those interested in teaching elementary and middle school disagreed or strongly disagreed with the statement. Of PSTs who were exposed to learning another language, 44% agreed or strongly agreed with the statement, compared to 55% of those without such exposure.

Examining the questions about teaching, in tm29r we see that 65% of PSTs who were exposed to EL issues in prior coursework disagreed or strongly disagreed that they would use limited vocabulary to make the content clear to EL students, compared to 55% of those PSTs who were not exposed to similar courses. Only 40% of teachers with 5-10 years of teaching experience (of 10 total) agreed or strongly agreed compared to about 60% of PSTs with no teaching experience and 70% with 0-4 years of teaching experience. For the PSTs who were not exposed to learning another language, 72% agreed or strongly agreed with the statement, compared to 60% of PSTs who did have this exposure.

In item tm33, 81% of females compared to 65% of males agreed or strongly agreed that rich classroom discussions were necessary for EL students to learn mathematics. In this item, 70% of teachers with 5-10 years of experience and 70% of PSTs interested in teaching middle school agreed or strongly agreed, compared to 86% of those with 0-4 years of experience and about 81% of PSTs teaching at the elementary level, respectively. In all other demographic variables, the percent of PSTs who agreed or strongly agreed with the statement ranged from 76% to 83%.

Discussion

This study outlined two clusters of PSTs based on their responses to the survey. Though these two groups differed significantly on 21 items, the five items on which the two clusters did not significantly differ in their beliefs were of interest to us since the beliefs appear to be uniform across the participants.

The deficit beliefs indicated by the PSTs in general regarding parents and cultures (item dc24r) are supported in previous findings (e.g., Milner, 2005; Valdes, 2001; Walker, Shafer, & liams, 2004). Further examination of the responses by individual demographic subgroups showed that PSTs held deficit beliefs even when exposed to EL issues within coursework or having prior classroom teaching experience. Given their prior experiences in the classroom, one might have expected the PSTs in the latter group to be aligned with the research. However, if the PSTs view parental involvement through a traditional paradigm as outlined in the research (e.g., Souto-Manning & Swick, 2006), then any instances where parents did not operate within this paradigm might serve to further teachers' deficit beliefs. Additionally, while exposure to EL issues within coursework could help PSTs develop non-deficit beliefs about parents and cultures, it is unknown how the PSTs that responded to our survey were challenged (if at all) to consider family involvement within their coursework.

The percentage of those Hispanic and African-American PSTs (though admittedly from a small sample) that reported deficit beliefs about how parents from different cultures value education showcases that deficit views are also not restricted solely to White PSTs. While these PSTs are a part of historically underserved and underrepresented populations, one possibility for the existence of these views is that the PSTs used their own experiences as a norm. As such, they may have wondered why if they worked hard (either academically or financially) to be able to attend a university (something they may see as a result of their family life), other individuals could not do the same. In this case, the PSTs attribute any lack of success in school to an individual student, family, or culture. In other words, they may believe that some students are not successful in schools because the students or the parents do not work hard enough or do not care enough. As a result, the PSTs conclude that some parents do not value education as much as others, rather than that there are systematic inequalities in the educational system for ELs such as the ones documented in California (Gándara, Rumberger, Maxwell-Jolly, & Callahan, 2003).

For item dc23r, we see that PSTs who self-reported as Hispanic or Asian and PSTs who had experience in learning another language were generally more in-line with the research than other demographic groups. This alignment may be due to the possibility that they were themselves ELs. Likewise, the other PSTs, whose responses were not aligned with the

research, may have been native English speakers. If this is the case, this finding speaks to the idea that for some PSTs the challenges they face as being members of a minority culture (such as African-American) are not necessarily the same challenges that ELs will face. Consequently, they, as well as other PSTs from the dominant culture, may not be able to empathize with being an EL and therefore hold deficit beliefs.

Across clusters, the majority of PSTs believed that mathematics is an ideal subject to transition ELs into learning English. However, PSTs who wished to teach high school and PSTs with exposure to learning a second language had a majority of responses (above 50% of the responses) that were aligned with the research. For those individuals who wanted to teach high school mathematics, it is possible that their content expertise included an understanding of the linguistic difficulties that are inherent in the study of mathematics. Thus a deeper understanding of mathematics has the potential to strengthen PSTs' understanding of the interconnection of language and mathematics. The PSTs who were exposed to learning a second language may have referenced their experiences and understood that there was no one classroom context which was ideal for someone to learn a second language, a finding that is in-line with prior research. Specifically, Griego-Jones (2002) suggested that individuals who increase their fluency in another language would be more empathic to the challenges that someone encounters when learning another language. However, it is also possible that these PSTs focused on a perceived difficulty in learning mathematics. Prior research (McLeman, 2012) has shown that some PSTs view mathematics as challenging, so they wonder how someone can simultaneously learn mathematics and language.

Concerning the teaching of mathematics to ELs, PSTs from both clusters were generally aligned with the research. This finding lends support to the notion that mathematics teacher education has been successful at helping PSTs understand the benefits of reform-based mathematics instruction, where student construction of conceptual understandings is ideal. It is possible though that the PSTs did not consider the specific population of ELs when responding to the items. Rather they may have felt that the items simply represented good teaching strategies, as discussed by de Jong and Harper (2005). Yet, more than two-thirds of the PSTs who reported that they had prior exposure to studying issues related to ELs tended to have more non-deficit views than those who did not. Therefore, an increased focus on ELs within teacher preparation may help prepare PSTs to work with ELs, something that is needed given the projected demand for EL teachers by 2013 (Casteel & Ballantyne, 2010).

Implications

Considering the propensity for teachers to hold deficit beliefs (Milner, 2005; Valdes, 2001; Walker, Shafer, & liams, 2004), teacher educators must challenge PSTs to reconsider when and if these beliefs emerge. If not, PSTs may develop as professionals who will predetermine (either consciously or not) the success or failure of certain students. The findings from this study suggest that PSTs need targeted support in re-considering their perspectives about parental and family involvement in education. Specifically, PSTs need help in re-imagining the various ways that parents and families value the education of their children, many of which are not visible (Souto-Manning & Swick, 2006). One way to accomplish this is for teacher educators to integrate into teacher preparation coursework structured reflective opportunities in which PSTs can experience students' cultural resources. Examples can include reflective, task-based interviews with ELs in content courses (Fernandes, in press) or organized events within the communities where PSTs are completing field-based practicums. As the findings of this study show, these experiences must occur regardless of the race/ethnicity of the PST, as mathematics teacher educators cannot assume that PSTs from ethnic minority groups hold non-deficit beliefs.

The findings from this study also suggest that an increased knowledge in mathematical content has the potential to help PSTs see interconnection of language and mathematics. However, given the large percentage of PSTs who saw mathematics as an ideal environment for learning English, mathematics teacher educators must make explicit the linguistic features present in mathematics, going beyond the syntax of symbolic manipulation (Barwell, 2005; Moschkovich, 2010). As a first step, mathematics teacher educators can make a deliberate effort in their practice to model the way mathematical claims are conjectured and justified. In addition, mathematics teacher education programs can and should incorporate knowledge related to language development and second language learning into both pedagogy *and* content courses (Fernandes, in press; McLeman, 2012; Nevárez-La Torre, Sanford-DeShields, Soundy, Leonard, & Woyshner, 2008).

Further research is needed to explore and confirm the findings seen in this study. One future direction planned as a follow-up to this study is a set of interviews with PSTs about their interpretations of the items related to culture and the interconnection of language and mathematics. Additionally, the survey with additional questions in these two areas will be piloted with another set of PSTs.

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