

Regarding the Mathematics Education of English Learners: Clustering the Conceptions of Preservice Teachers

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In this article, using survey data, the authors examined conceptions about the mathematics education of English learners (ELs) from 292 preservice teachers (PSTs) in urban universities through cluster analysis to determine if certain background characteristics influenced the formation of homogeneous clusters. An analysis of the findings shows a two-cluster solution, where respondents in cluster 2 ($n = 187$) were more aligned with research on the mathematics teaching and learning of ELs than respondents in cluster 1 ($n = 105$). Further, a chi-square test revealed that PSTs with three characteristics—exposure to issues related to ELs, field experience, and being female—were significantly higher in cluster 2 than cluster 1. The findings provide compelling evidence that exposure to EL issues impact the conceptions that PSTs regarding the mathematics education of ELs.

KEYWORDS: English learners, mathematics education, preservice teachers, mathematics teacher education, urban education

Teacher preparation programs play an important role in how and where teachers learn about practice (Gay, 2009). Yet, in the case of English learners (ELs¹), teacher preparation has not kept up with the high growth of ELs in the classroom. During the decade spanning 1998 to 2008, ELs accounted for nearly 50% of the growth in the overall Pre-K–12 student population in the United States

¹We view English Learners as those students who are still developing a proficiency in English and may, but do not always, consist of students who speak a language other than English at home.

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(National Clearinghouse for English Language Acquisition, 2010), a majority of which were educated in mainstream urban classrooms (Costa, McPhail, Smith, & Brisk, 2005). For example, 70% of elementary-aged ELs are educated within approximately 10% of the classrooms in the nation, a predominance of which is located within urban areas (Consentino de Cohen, Deterding, & Clewell, 2005). However, several researchers have reported that teachers do not feel that they are prepared to face the economic, demographic, and technological realities present in schools, including the education of ELs (see, e.g., Durgunoğlu & Hughes, 2010; Levine, 2006; Mayer & Phillips, 2012).

In consideration of the large percentage of ELs within urban schools, we were interested in understanding the conceptions of preservice teachers (PSTs²), who attended universities located within urban settings. We conjectured that PSTs from these universities might have had multiple interactions with ELs, either as students or through field experiences, and therefore have developed specific conceptions of teaching mathematics to ELs. As such, in this study we sought to classify urban PSTs into groups or clusters based on their reported conceptions about the mathematics education of ELs. Specifically, we researched the following question:

1. For PSTs who attend universities that are situated within an urban context, how do their conceptions about the mathematics education of ELs cluster?
2. What prior characteristics might account for the formation of these clusters?

Literature Review

Numerous studies address how pre- and in-service teachers conceptualize cultural and linguistic diversity or the inclusion of ELs in mainstream classrooms (e.g., Byrnes & Kiger, 1994; Flores & Smith, 2008; Hansen-Thomas & Cavagnetto, 2010; Reeves, 2006). However, all these studies examined conceptions of diversity in contexts that were not specific to the mathematics teaching and learning of ELs. For example, Byrnes, Kiger, and Manning (1997) used the 13 item Language Attitudes of Teachers Scale (LATS; Byrnes & Kiger, 1994) to measure the attitudes that 191 teachers had about language diversity and linguistically diverse students in three states. Youngs and Youngs (2001) used two items adapted from LATS to examine the nature of attitudes of 143 teachers towards ELs and predictors of these attitudes. They found that teachers who completed a foreign language or multicultural course, had English as a Second Language (ESL) training,

² For the purposes of this study, preservice teachers are those students enrolled in university-structured teacher preparation programs.

experience abroad, worked with diverse or ESL students, and were female had more positive attitudes towards ELs. As another example, Pohan and Aguilar (2001) developed the personal and professional belief scales that Akiba (2011) used to examine the change in beliefs about diversity that took place after PSTs attended a diversity course and had a field experience. Reeves (2006) also used part of Pohan's and Aguilar's scale to measure the attitudes that 279 subject-area teachers had towards including ELs in their classroom.

As Janzen (2008) noted there is a dearth of studies that document how PSTs conceptualize the instruction of ELs within the specific context of mathematics. According to Cooney, Shealy, and Arvold (1998) and Philipp (2007), beliefs and knowledge are tied to context and different contexts will elicit different conceptions. This study contributes to the literature by examining PSTs' conceptions about ELs within the context of mathematics. PSTs generally believe that mathematics involves symbols and is less language intensive than other subjects (Garrison & Mora, 1999; Walker, Ranney, & Fortune, 2005). However, numerous linguistic demands exist, including unpacking questions that contain complex phrases in the statements of problems, making arguments, justifying reasoning, and building on other's arguments (Bailey, 2007; Barwell, 2005b; Moschkovich, 1999, 2010; Schleppegrell, 2010). Teachers must understand linguistic complexity and make content comprehensible for ELs by providing linguistic and contextual support (Echevarría, Vogt, & Short, 2008; Gibbons, 2002), like modeling mathematical talk (Khisty & Chval, 2002) and scaffolding procedures (Gibbons, 2002). We sought to understand the conceptions of PSTs from urban universities. Additionally, we wanted to determine how the conceptions clustered and what characteristics might account for this clustering.

Conceptual Framework

Conceptions, according to Pratt (1992), are specific meanings of phenomena and impact how individuals view the world. We viewed the construct of conceptions similar to Kitchen, Roy, Lee, and Secada (2009), namely that conceptions constitute both knowledge and beliefs. For our study, the conceptions that research indicates PSTs would need in order to be effective mathematics teachers to ELs guided the development and interpretation of a survey we created. Specifically, we framed the item design and data analysis through a non-deficit perspective of working with ELs. According to Civil (2007) and Moschkovich (2010), these perspectives assume that EL students have valuable resources, including their culture and language, which can and should be used as an integral part of mathematics instruction. In this study, the use of an EL's native language was viewed as a resource in order to promote an EL's acquisition of the academic language of mathematics in English (Garrison & Mora, 1999). Further, all parents from all

cultures were seen to value the academic growth of their children (Civil, Planas, & Quintos, 2005), even if their ways of participating within the school structure did not fit within the traditional paradigm of parental involvement (e.g. attending parent-teacher conferences, volunteering in classrooms, etc.). Thus in framing, and later scoring the items, we assumed that bilingualism and an EL's home culture were assets to the mathematical learning of an EL.

Based on the framework of our survey, review of the literature, consultation with experts in the field, and our experience as mathematics educators, we created items for our survey that would assess PSTs' conceptions in areas that would impact the mathematics education of ELs

- interconnection of language and mathematics,
- teaching mathematics to ELs,
- language in the school context,
- fairness, and
- diverse cultures.

These five areas guided the development of items for the survey as well as the analysis of the each of the participant's responses. Throughout the findings, when appropriate, we frame the participants' responses in terms of key findings from these areas of literature.

Methodology

The Survey Instrument

The survey consisted of 26 items that measured the strength of agreement or disagreement of PSTs' conceptions about the mathematics education of ELs on a 5-point Likert-type scale: Strongly Disagree (1), Disagree (2), Undecided (3), Agree (4) and Strongly Agree (5). The 26 items on the survey were broken up into the five categories seen in Table 1. Additionally, participants were asked to provide demographic information, including gender, race, and knowledge of another language. Additionally, we asked participants if they had been exposed to EL issues through courses in their degree programs, and if they worked in classrooms as part of course-based field experiences.

Even though there are disadvantages to using a survey to measure PSTs' conceptions (see Ambrose, Clement, Philipp, & Chauvot, 2004), we chose to do so for two primary reasons. First, we were concerned that PSTs might answer in a manner they thought was expected of them if we used an interview setting. Second, there are no large-scale studies that can complement the small-scale qualitative studies about the conceptions that PSTs have.

Table 1

Breakdown of Survey Categories with Number of Items in Each Category

Category	Number of Items
Language in the school context (lsc)	8
Interconnection of language and mathematics (ilm)	3
Diverse cultures (dc)	4
Teaching mathematics to ELLs (tm)	8
Fairness (f)	3

Validity of the Instrument

A pilot version of the survey was developed and tested with PSTs at one university in the southeast United States. The findings of that survey were used to check PSTs' interpretations of the items. After the items were refined, we ensured content validity by consulting 10 experts in the field, whose suggestions were incorporated into a further refinement of the survey items. Face validity of the survey was addressed by asking PSTs at the end of the survey to answer three open-ended questions to determine the readability and clarity of the survey.

Data Collection

PSTs conceptions were measured through an online survey. Data from 294 PSTs from universities situated within urban contexts from 12 different states around the United States were collected. For our purposes, a university that was located in an area with a highly dense population (based on classifications from the United States Census Bureau³) was considered to be located within an urban context. We recruited the participants through personal requests to other mathematics teacher educators working with PSTs. All potential participants were provided a web link that directed them to the survey that was hosted on Survey Share (see <http://www.surveymshare.com/>).

Data Analysis

We analyzed the data using cluster analysis, a method that creates groups of respondents based on high within-cluster homogeneity and high between-cluster heterogeneity (Hair & Black, 2000). The data were prepared for analysis by reverse coding certain items based on our conceptual framework of non-deficit conceptions. A score of 1 represented a response that was least aligned with the research literature regarding ELs with a score of 5 representing a response that was most aligned. We conjectured, for example, that a PST who conceptualized that an EL's culture could negatively impact an EL's mathematical learning would be less open to seeing certain ELs' home cultures as a resource in the classroom. In

³Visit <http://www.census.gov/geo/www/ua/2010urbanruralclass.html> for more information.

total, 14 of the 26 items on the survey were reverse coded and are indicated with an *r* after the number.

The next stage of preparation involved pre-screening the data for outliers based on the responses of the PSTs to the 26 items. Outliers tend to distort the results of statistical tests and need to be removed at the outset (Aron & Aron, 1997); cluster analysis in particular is sensitive to outliers. The Mahalanobis distance for multivariate data ($p < .001$) was used to determine the outliers (Stevens, 1992; Tabachnick & Fidell, 1996). There were two outliers that were dropped from the subsequent analysis making the total number of responses examined 292.

Cluster Analysis

We used hierarchical cluster analysis using Ward's method to identify those respondents who had a high homogeneity of responses related to the 26 statements, with an end goal of identifying the characteristics of these groups. We examined the difference between the coefficients to determine the number of clusters. A new cluster was determined when the distance between a pair of adjacent coefficients was not relatively stable when compared to all other pairs of adjacent coefficients (Milligan & Cooper, 1985). Upon examination of the re-formed agglomeration table, the approximate jump in coefficients of 640 between the last two stages of clustering and the relatively stable distance between all other pairs of adjacent coefficients (approximately 229, 200, and 155 for the next three pairs of adjacent coefficients, respectively) suggested a two-cluster solution. This jump is displayed in the distance on the right of the dendrogram given in Figure 1, which points to increasingly dissimilar clusters being combined. The two-cluster solution was validated by splitting the data into two equal sets and confirming the persistence of the same solution for the split data (Hair & Black, 2000).

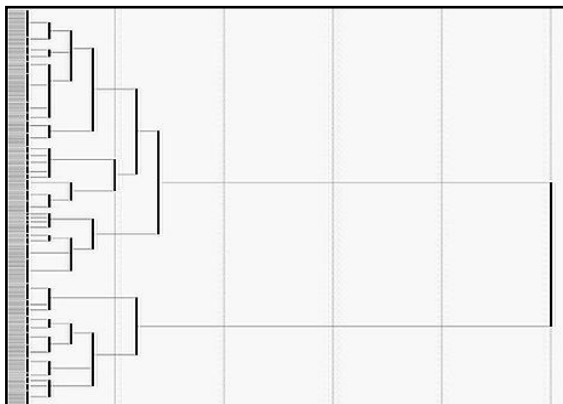


Figure 1
Dendrogram showing
two-cluster solution.

Cluster Description

Once the two-cluster solution was validated, demographic information was used to profile the two clusters. A chi-square test ($p < 0.05$) was performed on each demographic variable to seek its association to cluster membership. This profiling was extended to see how the PSTs in the two groups differed in their responses to the 26 items, as the goal was to identify the characteristics of each cluster. The differences between the means of Cluster 1 (C1) and Cluster 2 (C2) for each of the 26 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. We also performed independent samples t -tests using each of these variables as the grouping variable to determine the specific items where there was a significant difference between the means of C1 and C2. Finally, given that the purpose of cluster analysis is to seek heterogeneous groups, significant differences between the means of the clusters are expected (Hair & Black, 2000). Thus, the items where the differences between means were not significant were also documented.

Findings

The first part of our findings describes the characteristics of the entire sample of 292 PSTs and the two clusters; the second examines items whose cluster means showed a significant difference and a difference in alignment to the research; and the third part examines items whose means did not differ between the two clusters.

Sample

The sample of PSTs who responded to the survey was comprised of 86% females and 14% males. Additionally, 85% were White, 7% were Black, 3% were Hispanic, and 2% were Asians. Most of the PSTs were interested in teaching K–5 (75%), with 14% and 11% interested in teaching middle and high school, respectively. The majority of PSTs had less than four years experience teaching, with 73% having no experience and 25% having between 0–4 years. A majority (78%) of the sample had some field experience, and 74% of the PSTs were exposed to issues related to ELs through their courses in their degree programs. Though most of the PSTs had experience learning a second language (86%), there were only 8% who were actually fluent in another language. Of those who self-reported that they were fluent in another language, 6 of 8 PSTs were Hispanic, 4 of 6 PSTs were Asian, and 9 of 239 PSTs were White. Table 2 presents the number of respondents in each cluster, broken down by each demographic characteristic.

Table 2
Number of Respondents Per Demographic Variable

	Cluster 1 (C1) 105	Cluster 2 (C2) 187	Total 292
Gender	Male: 21	Male: 19	Male: 40
	Female: 84	Female: 168	Female: 252
Teaching Interest	Grades K-5: 76	Grades K-5: 144	K-5: 220
	Grades 6-8:18	Grades 6-8:23	Grades 6-8: 41
	Grades 9-12:11	Grades 9-10:20	Grades 9-12:31
Teaching Experience	None: 77	None: 135	None: 212
	0-4 years: 24	0-4 years: 48	0-4 years: 72
	5-10 years: 4	5-10 years: 4	5-10 years: 8
Field Experience	Yes: 72	Yes: 155	Yes: 227
	No: 33	No: 32	No: 65
Exposure to EL issues	Yes: 67	Yes: 149	Yes: 216
	No: 38	No: 38	No: 76
Fluency in another language	Yes: 6	Yes: 17	Yes: 23
	No: 99	No: 170	No: 269
Experience learning a second language	Yes: 91	Yes: 159	Yes: 250
	No: 14	No: 28	No: 42

As Table 2 indicates, the ratio of individuals from C2 to those from C1 is about two-to-one (2:1) for almost every demographic component. In other words, there is about twice the number of individuals in C2 than in C1 across most demographic variables. For example, there are 144 participants in C2 that desire to teach grades K–5 as opposed to 76 in C1, a ratio of 1.89 to 1. However, there were significant associations for only three of the demographic variables and membership to C2: gender ($\chi^2(1)=5.507, p<.05$), exposure to EL issues ($\chi^2(1)=8.796, p<.05$), and field experience ($\chi^2(1)=7.946, p<.05$). This means, in the case of gender, the proportion of females in the two clusters is significantly different and females are more likely to be in C2 than C1.

Significant Differences in the Two Clusters

Our analysis of the data revealed significant differences ($p < 0.05$) between the means in 21 out of the 26 items. However, here, we focus on the eight items where the two clusters were not only significantly different but also differed in their alignment to the research; that is, one cluster mean was more than three and the other was less than three. (Even though there were significant differences be-

tween the means for the other 13 items, both clusters on the whole agreed or disagreed with the item.) The eight (paraphrased) items are summarized as follows, with the cluster means and the percentage of undecided responses (3 on the Likert scale) for each item given in Table 3.

- **lsc13r**: Learning English is more important than native language.
- **lsc15r**: Speaking in a language other than English hampers the learning of English.
- **lsc16**: State math tests should not be offered in different languages.
- **lsc18r**: After one year, ELs are capable of rich math discussions.
- **f35r**: The math work of ELs and non-ELs should be evaluated the same.
- **tm32r**: ELs and non-ELs should be taught math in the same way.
- **ilm20r**: Conversational fluency implies capability to learn math like non-ELs.
- **dc25r**: Inherently, ELs from some ethnicities are better at math than others.

Table 3
Items That Were Significantly Different and Had Differing
Cluster Alignment to Research

ITEM	CLUSTER 1 (C1)		CLUSTER 2 (C2)	
	Mean	% Undecided	Mean	% Undecided
lsc13r	2.6857	36.2	3.5668	20.86
lsc15r	2.8762	31.42	3.7326	23.53
lsc16	2.9619	24.76	3.8128	23.53
lsc18r	2.8952	51.42	3.2781	35.83
f35r	2.6476	32.38	3.3529	26.74
tm32r	2.7714	27.62	3.7059	24.06
ilm20r	2.5333	24.06	3.5187	23.81
dc25r	2.7619	39.05	3.2781	30.48

Of the eight questions asked regarding language in the school context, the two clusters had differing alignment to the research for four of the items. About 45% of the respondents in C1 conceptualized that learning English is more important for ELs than maintaining their native language (lsc13r) compared to 17% in C2. On the other hand, only about 19% of respondents in C1 did not think that learning English was more important, where about 62% of the respondents in C2 did. About one-third of the respondents in C1 also conceptualized that the use of native language would hamper an EL's learning of English (lsc15r), with about only 8% of respondents in C2 sharing this conception. This pattern of responses was observed for item lsc16 as well. More than one-third (about 38%) of the PSTs in C1, based on their conceptions, felt that state tests should not be offered in different languages, where only 8% in C2 thought that this should be the case. For the last item, lsc18r, both C1 and C2 had a similar percentage of respondents that thought ELs could have rich mathematical discussions after being immersed in

English for a year: about 29% of the respondents from C1 and about 20% from C2. Further, many of the PSTs in both clusters did not seem to have a definite view on this topic, with over half (51%) of the PSTs in C1 and a little over a third (36%) of the PSTs in C2 indicating that they were undecided.

The lower means for C1 in the four items point to a common misconception described in the second language acquisition literature that more time spent learning English will allow for a faster acquisition of the language (Gandára & Contreras, 2009). However, this model helps ELs only acquire conversational language and not the academic language required for them to communicate their understanding of the content (Cummins, 2000). Cummins pointed out that it takes 5–7 years to acquire academic language proficiency, as opposed to 1–2 years for conversational fluency. To facilitate the comprehension of content, it is recommended that ELs can have richer discussions with each other or the teacher when they converse in their native language (Domínguez, 2011; Gutiérrez, 2002; Moschkovich, 2010). Furthermore, researchers (e.g., Gandára & Contreras, 2009) have discussed that the rate of acquisition in immersion and bilingual programs are about the same, a usual critique of bilingual education. Clarkson (1992) and Garrison and Mora (1999) also pointed out that if students have learned content in their native language, as in the case of new immigrants, then after acquiring a certain threshold proficiency in both languages, they are able to transfer their mathematical knowledge from one to the other. So if native language benefits ELs' comprehension of the content, allows for meaningful participation, and does not impact their rate of English acquisition, then it is advantageous for a teacher to be open to its use in the classroom.

The misconception between conversational and academic language can be seen in the responses to ilm20r. PSTs in C1 were more likely to confuse fluency in conversational language with academic language fluency than PSTs in C2. In C1, 59% of the respondents either agreed or strongly agreed with the statement compared to 17% who either disagreed or strongly disagreed. In comparison, the percentages for C2 were reversed, with about 17% of respondents in C2 having either agreed or strongly agreed with the statement versus 59% who either disagreed or strongly disagreed. The high percentage of respondents in C1 that agreed may indicate those PSTs do not see mathematics and language as inseparable (Barwell, 2005b), but rather as mutually exclusive constructs. Researchers, such as Schleppegrell (2007) and Veel (1999), have pointed to the linguistic demands in mathematics that go beyond conversational fluency which would be required by the students to meaningfully participate in the classroom mathematics community.

In items tm32r and f35r we observe the impact that some of the PSTs' conceptions about language have on their conceptions of teaching ELs. About 50% of the respondents from C1 indicated that they would not differentiate how they

evaluated the mathematical work of ELs (f35r), with 18% agreeing that they would evaluate ELs differently. In contrast, these percentages for C2 were 22 and 51, respectively. In the context of fairness, about 44% of the respondents in C1 agreed that they would teach ELs in the same way that they taught non-ELs (tm32r), as opposed to 8% of the respondents in C2. Research (e.g., Bunch, 2010; Campbell, Adams, & Davis, 2007; de Jong & Harper, 2005) has shown that there are extra cognitive demands on ELs as they try to understand new content in a language they are still learning. Thus there is a need for ELs to have modifications and accommodations such as providing linguistic and contextual supports through scaffolding (Gibbons, 2002) or by providing extended time for ELs to interact with peers and teachers about academic content (Echevarría, Vogt, & Short, 2008; Hanson & Filibert, 2006). Working within this paradigm, fairness does not mean sameness, something that the PSTs in C1 seemed to assume.

Finally, we examine PSTs' conceptions about EL students' inherent ability to do mathematics (dc25r). About 41% of the respondents in C1 felt that some ELs were inherently better at mathematics, as compared to only 24% in C2. While for each cluster there was a high percentage of respondents who were undecided (about 39% for C1; 30% for C2), only 20% of the respondents in C1 disagreed that there was an inherent difference in mathematical ability for some ELs, compared to about 45% for C2. Previous research (e.g., Chval & Pinnow, 2010; Guttman & Bar-Tal, 1982) supports these conceptions, specifically that PSTs can have stereotypical beliefs about students based on the language that the students speak. For example, they may believe that Asian students are better at mathematics than Latina/o students, even though they are both ELs (Chval & Pinnow, 2010). Though some languages like Chinese seem to offer advantages to speakers when formulating numbers, generalizing this to an overall superior mathematical ability is not a given (Yee, 1992).

It is possible that some of the PSTs considered only the difficulty of the discipline of mathematics. As noted earlier, some PSTs may have separated the ideas of language and mathematics. This separation might lead them to feel that an EL's grasp of mathematics is not dependent on knowing English but rather on the difficulty of mathematics itself. In other words, they might feel that ELs would have difficulties in a mathematics classroom regardless if they can converse in English since mathematics itself is inherently difficult (McLeman, 2012).

Non-significant Differences in the Two Clusters

Significant differences between means of the two clusters are quite natural in cluster analysis, given that the process seeks to form heterogeneous groups. Consequently, differences that are not significant can also provide mathematics teacher educators insights about conceptions that are held across PSTs. In our

analysis, 5 of the 26 items did not show a significant difference ($p < 0.05$) in means (see Table 4). Specifically, these (paraphrased) items are

- **ilm19r**: Math is an ideal subject for beginning ELs to learn English.
- **dc23r**: Some cultures negatively impact ELs' learning of math.
- **dc24r**: Parents in some cultures place a higher value on education than parents from other cultures.
- **tm29r**: Limited math vocabulary helps ELs learn math.
- **tm33**: ELs need discussion rich classrooms to learn math.

Table 4
Items That Were Not Significantly Different

ITEM	CLUSTER 1 (C1)		CLUSTER 2 (C2)	
	Mean	% Undecided	Mean	% Undecided
ilm19r	2.5905	30.48	2.6096	27.62
dc23r	2.7238	36.19	2.8289	33.69
dc24r	1.9333	9.52	1.8877	8.02
tm29r	3.4762	25.71	3.6096	23.53
tm33	3.8857	16.19	4.0321	17.11

Given the conception among PSTs that mathematics is a universal language (Garrison & Mora, 1999; Walker, Shafer, & Iiams, 2004) it was not surprising that both clusters had mean scores that were not aligned with the extensive research that describes the prevalence of language in the teaching and learning of mathematics. By extension both clusters also conceived that mathematics would be easier than other subjects for EL students. These conceptions match with those expressed by middle school teachers who assumed that mathematics would be easier for EL students because numbers are universal (Hansen-Thomas & Cavaghetto, 2010).

The majority of the PSTs had a definitive view about parents as indicated by the low percentage of undecided responses in each cluster. About 84% of the respondents from C1 and about 86% of the respondents from C2 agreed with the idea that there are parents from some cultures that value math education more than others (dc24r). Further about 45% and 40% of the PSTs from C1 and C2, respectively, saw that some ELs' home cultures would negatively impact their learning of mathematics. These conceptions are supported in the research where minority parents and the communities in which they live are considered to be primary reasons for ELs' failure in schools (Pappamiheil, 2007).

Finally, we see that PSTs in both clusters were aligned with research regarding the importance of discussion rich mathematics classrooms for ELs. In particu-

lar, about 80% in both C1 and C2 agreed creating classrooms that promote rich language development is necessary in the mathematics instruction of ELs.

Discussion

In this study, we were interested in examining how the conceptions about the mathematics education of English learners (ELs) from preservice teachers (PSTs) who attend universities situated within urban contexts cluster. Further we were interested in what prior characteristics might account for this clustering.

Overall, cluster analysis on the 292 PSTs' responses to the 26 items yielded a two-cluster solution with C2 ($n = 187$) more aligned with research than C1 ($n = 105$). Close examination of the demographic distribution shows C2 was more likely to contain PSTs who were female, exposed to EL issues in prior courses, and who had field experiences. These three characteristics of PSTs were similar to some of the predictors that previous research (e.g. Byrnes et al., 1997; Youngs & Youngs, 2001) has found supports working with ELs in productive ways. Youngs and Youngs noted that teachers would be more positive about working with EL students if they have been educated about working with this population. In regard to gender, given that the proportion of females is significantly more in C2, this would seem to confirm other research that females were more open or accepting of diversity issues within the classroom (e.g., Akiba, 2011; Pohan & Aguilar, 2001; Taylor, Peplau, & Sears, 1999; Ottavi, Pope-Davis, & Dings, 1994; Youngs & Youngs, 2001).

With gender, exposure to EL issues, and field experiences showing significant differences in group membership, it appears that providing field experiences in conjunction with readings concerning the education of ELs within teacher preparation can be a fruitful avenue to align PSTs' conceptions to research. Thus, further analysis was conducted on the eight items that had significant differences in means and differed in their alignment to the research given that these items spanned the three characteristics that were significant to membership in C2. Findings from this secondary analysis showed that exposure to EL issues, gender, and field experiences were significant for item tm32r (teaching both ELs and non-ELs in the same way). Moreover, exposure to EL issues and gender were also significant for items lsc13r (learning English is more important), ilm20r (conversational fluency implies academic fluency), and f35r (evaluation of math work should be the same). In other words, the means of the respondents with exposure to EL issues and who were female were significantly different from the means of those without exposure and who were male. Finally, in addition to the previously mentioned items, a significant difference was also found between the means for the respondents who had exposure to EL issues and those who did not for items

lsc15r (speaking another language hampers the learning of English) and lsc16 (state math tests should be in different languages).

As C2 was more likely to contain PSTs with these characteristics and to have items means that were aligned with the research, in comparison to C1, these findings mirror those of Cho and DeCastro-Ambrosetti (2006) in providing compelling evidence that exposure to EL issues is one of the most important factors in helping PSTs have non-deficit views about the mathematics education of ELs. In particular, findings from this study suggest that when PSTs have had exposure to EL issues they are more likely to understand the language demands of mathematics. For PSTs in C2, this idea translated to seeing that conversational language fluency is not equivalent to academic language fluency and an EL's need to speak in their native language would not hinder their development of learning English. Through their conceptions, the PSTs in C2 also seemed to understand that an EL's linguistic needs must be acknowledged with accommodations to lesson planning, evaluation, and offering state-mandated assessments in languages other than English. Moreover, akin to the findings seen by Olmedo (1997), field experiences coupled with the knowledge gained about considering issues related to ELs may have provided PSTs avenues to begin to challenge the notion that teaching does not have to be exactly the same in order to be fair.

With less knowledge about and experience working with EL students, the findings from this study show that PSTs hold deficit-based conceptions about the mathematics education of ELs. For example, like the teachers in Reeves's (2004) study, the PSTs in C1 felt that using the same standards to evaluate both ELs and non-ELs was fair perhaps because state and nationalized standardized do not alter testing for different populations of students. Alternatively, the PSTs may have felt that ELs must be treated in the same exact way as non-ELs so as not to differentiate based on ethnicity and/or race, among other things, given that differentiating might be associated with discriminating. It is also possible that the PSTs believed that modifying standards or teaching differently would not best prepare ELs for the future. As one teacher in Reeves's study noted, "the real world" (i.e., future employers) will not make such accommodations. What is problematic about this view, and something that teacher educators must challenge PSTs about, is that it chooses to ignore the systemic inequalities underserved and underrepresented populations such as ELs face in the educational system (Oakes, 2005). Moreover, teacher educators need to make explicit to PSTs that, as research has shown (e.g., Brimijoin, 2005), teachers can differentiate instructional/assessment strategies while still preparing all students to be successful on standardized assessments.

Non-significant Differences

Cluster analysis was especially useful in isolating the conceptions that were held across the entire group of participants. In this study, ideas that cut across all

participants were related to PSTs' conceptions about the universal nature of mathematics with minimal use of language and a deficit view of parents and communities of EL students. These findings point to areas that can be targeted in teacher preparation through exposure to EL issues in combination with appropriate field experiences. Moreover, it is important to understand how PSTs consider the use of language in mathematics classes as well as how their interpretations might differ from that of researchers (e.g., Bailey, 2007; Barwell, 2005a; Moschkovich, 1999).

It is unclear if the PSTs alignment to the research on best practices of teaching mathematics to ELs shows familiarity with this research or if the responses stem from a desire to promote good teaching for all (de Jong & Harper, 2005). For the PSTs in C1, in particular, the latter seems likely considering their unalignment with the research on all other ideas regarding the mathematics instruction of ELs. Indeed, based on recommendations from organizations such as the National Council of Teachers of Mathematics (2000), teacher preparation programs have helped PSTs consider best practices to teach mathematics to all students, including the need to promote discussion within mathematics classrooms. It is important to note that while these types of recommendations are important, they are not synonymous with the construction of a discussion-rich classroom needed to facilitate the academic language and content knowledge of ELs such as the one detailed by Khisty and Chval (2002).

Limitations

In general, each of the items discussed in this article had high percentages of respondents indicating that they were undecided. For C1, this percentage ranged from about 25 to 51 on the significantly different items. For C2, this range was slightly lower, from about 21% to 36%. With almost 98% of PSTs indicating they understood what the questions in the survey were asking and a little more than 93% of PSTs indicating that there were no ambiguous questions, the high percentages of PSTs who chose the undecided response seems to indicate that they were indeed undecided on whether or not they agreed or disagreed with a particular item. For the respondents in C1 (where a larger percentage of undecided responses were seen), a possible explanation for this may stem from the lack of exposure or experience in thinking about issues related to educating ELs, a problem in many teacher preparation programs (Watson, Miller, Driver, Rutledge, & McAllister, 2005). Given that the proportion of individuals having exposure to issues regarding the mathematics education of ELs is significant to membership in C2, the individuals in C1 may have felt unprepared to indicate a view one way or another.

On the other hand, PSTs may have chosen to mark undecided as a response because they felt that every situation is different and that there does not exist one

correct way to educate ELs. As one PST indicated, “I feel that many of these would be a case by case therefore it is difficult to pick either agree or disagree.” In general, these PSTs are correct that there is not one way to educate students. However, research does provide us information about which systemic, societal, and instructional practices in general support ELs’ achievement (e.g., Cummins, 1981; Echevarría et al., 2008; Khisty & Chval, 2002; Moschkovich, 1999). Thus, while the PSTs were correct in stating that not every situation is the same, their responses indicate that they may not be familiar with some of the systemic ideas regarding the mathematics education of ELs.

Implications for Practice

In the past decade, research has called for the integration of linguistic issues into teacher preparation programs (e.g., Duff, 2001; Fillmore & Snow, 2002). This study supports those calls with findings revealing that issues related to the mathematics education of English learners (ELs) need to have a more prominent and integrated role within teacher preparation. For the PSTs in this study, all of whom attended universities situated within an urban context, exposure to EL issues and gender were significant factors in non-deficit conceptions. However, there were a number of PSTs who still held deficit views, which shows that these issues still remain an “add on” within the profession of teaching. For example, the Common Core State Standards do not address the mathematics education of ELs within the standards but rather attends to it within an addendum (see <http://www.corestandards.org/assets/application-for-english-learners.pdf>).

Addressing EL issues in context can benefit the learning of instructional strategies that will support ELs’ mathematical learning while also helping PSTs to understand the linguistic complexity inherent in the teaching and learning of mathematics. In particular, PSTs need help in re-considering their perspectives about parental and family involvement in education to see that there are various ways for parents and families to value the education of their children, many of which are not visible (Souto-Manning & Swick, 2006). Moreover, there is a need to foster an awareness of the linguistic aspects that arise in mathematics beyond the syntax of symbolic manipulation (see Bailey, 2007; Barwell, 2005a; Moschkovich, 1999). As Nevárez-La Torre, Sanford-DeShields, Soundy, Leonard, and Woynshneral (2008) detail, however, this awareness will only be achieved through a redesign of teacher preparation curricula where specialized courses focused on ELs are required and knowledge and domains related to second language, language development, and culturally responsive teaching, among other things, are integrated into pedagogy courses. The findings of this study support this type of redesign and extend it by noting that an inclusion of linguistic issues must also occur within content courses. PSTs need to be provided experiences within the context of mathematics (i.e., while doing mathematics) to help them better under-

stand the nuanced interconnection between language and mathematics (Fernandes, 2012). These experiences would include, among other things, teacher educators in mathematics courses explicitly noting the linguistic features present in mathematics.

Implications for Research

This study goes beyond current ones that examine PSTs' preparation regarding the education of diverse students. Instead this study focused on clustering the conceptions of PSTs who attended universities within urban settings, a unique contribution to the field of mathematics education considering the lack of studies in this area (Janzen, 2008). While this study confirmed many of the findings from previous research, speaking to the robustness of this research, patterns in some of the PSTs' conceptions merit further investigation.

To inform our perspectives for the improvement of teacher preparation of ELs, large-scale studies involving quantitative measures (such as the one reported here) and smaller-scale qualitative studies need to work in tandem. Specifically, PSTs' conceptions about the mathematics education of ELs should be investigated further through qualitative interviews in order to gain a deeper understanding. For example, since the PSTs in both clusters in this study reported conceptions about parents that were unaligned with the research with few undecided responses, future research will involve qualitative interviews with select PSTs to understand the deficit nature of this conception. Additionally, more demographic information can be collected in order to provide a stronger picture of how different populations of PSTs conceive of the mathematics education of ELs. Such information could include whether the PSTs themselves were classified as English learners in their K–12 education or what year study (e.g., freshman, sophomore) the PSTs are currently classified as at their institution.

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