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Hispanic Preservice Teachers' Peer Evaluations of Interdisciplinary Curriculum Development: A Self-Referenced Comparison Between Monolingual Generalists and Bilingual Generalists

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Abstract

This study investigated preservice teachers from two teacher education programs, elementary generalists and bilingual generalists (who will teach all subjects in both English and Spanish), about their instructional design abilities via examination of their ability to integrate interdisciplinary-themed activities into mathematics lessons. The findings illustrate the value provided by differentiating teacher preparation for preservice bilingual teachers—especially for challenging STEM-related (science, technology, engineering, and mathematics) subjects such as mathematics—based on their distinctive pedagogical, cognitive, and linguistic requirements.

Keywords

peer evaluation, teacher education, bilingual education, instructional design

Differences in cognitive capacities and academic achievements between bilingual and monolingual students had been investigated by a number of researchers throughout the past three decades, and findings consistently found that bilingual students—especially

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those with unbalanced bilingual communication abilities—demonstrated weaker competencies in all school subjects in K-12 grade levels compared with their monolingual peers (Baumert & Schümer, 2001; J. A. Cooper & Schleser, 2006). In particular, curricular subjects that require mathematical reasoning and problem-solving processes are highly dependent on the ability to effectively recall numeration facts, which requires configuring this information within verbal and linguistic formats during previous data storage, retrieval, and coding processes (Dehaene, Molko, Cohen, & Wilson, 2004; Domahs & Delazer, 2005). When dealing with mathematical tasks that were given in a secondary language, bilingual students used encoding and retrieving procedures involving language switching between information throughout the internal thinking process and external expression process (Marian & Fausey, 2006).

Such language-switching processes increase the cognitive load for bilingual students during mathematical processing tasks, necessitating provision of supplementary approaches for supporting such students (Saalbach, Eckstein, Andri, Hobi, & Grabner, 2013). In addition, bilingual students' background socioeconomic status is another key factor relevant in explaining why second language learners struggle more than their monolingual peers in learning and performing mathematics tasks (B. Cooper & Harris, 2005). For example, the application of mathematical problem-solving skills within real-world contextualized settings enables students to unite their life experiences with engaging mathematics pedagogy. Moreover, if mathematics teachers do not provide instruction that is relevant to their students' interests and background, then that might further hinder some second language learners during mathematics instruction (Ladson-Billings, 2009).

As a core school subject that is chiefly comprised of abstract and theoretical models as well as symbolized and sequential structures, the application of mathematical thinking is oftentimes difficult for English language learners to recognize and conceptualize within real-world contexts (Kilpatrick, Swafford, & Findell, 2001). Although Spanish–English bilingual programs have been widely offered in many school districts across the United States—and bilingual teachers have been prepared by teacher education programs to accommodate educational equity—nonetheless, it has been established within the research literature that traditional ways of teaching mathematics have limited impact on minority students throughout their K-12 learning progress, especially Hispanic students, in encouraging development of conceptual understanding and productive dispositions toward mathematics (Balfanz & Byrnes, 2006). Examples of mathematics pedagogy approaches that have been identified as ineffective at supporting bilingual students include (a) isolating mathematics from other school subjects and real life, (b) separating mathematics topics into rigid and disconnected units, and (c) lecturing about decontextualized examples and assigning students decontextualized questions (Singham, 2003).

Teaching mathematics through interdisciplinary pedagogy has demonstrated benefits for both bilingual students and bilingual teachers, as it allows students to explore mathematical concepts through multiple routes via connections that reach across school curricula borderlines, thereby enabling teachers to transcend traditional disciplinary boundaries as well as reduce redundancy across curricular subjects (Keen,

2003; Marrongelle, Black, & Meredith, 2003; National Council of Teachers of Mathematics, 2000; Zhou & Kim, 2010). Interdisciplinary learning experiences have been shown to strengthen regular students' higher order thinking abilities within analysis and synthesis processes, and also provided extra challenges and alternative avenues for students with language barriers to learn mathematics.

Mathematics instruction using interdisciplinary strategies has demonstrated the capacity to support bilingual students in learning mathematics, specifically by (a) increasing students' mathematical-themed communication during peer collaborations and working in teams (Ingram & Seashore, 2003); (b) transferring knowledge between empirical, real-life experiences and theoretical mathematical ideas (Catterall, 2005); (c) creating highly motivational mathematics learning environments encompassing decreased levels mathematics anxiety (An, Tillman, Boren, & Wang, 2014; Robertson & Lesser, 2013 , 2014); and (d) improving academic achievement in mathematics as well as related cognitive skills including creativity, originality, and the ability to recognize and comprehend multiple methods of problem representation (An & Tillman, 2015; Henson, 2015). In summary, design and implementation of mathematics lessons containing interdisciplinary-themed activities can provide preservice and inservice teachers with a bridge for linking mathematics pedagogy with educationally supportive resources that help make instruction meaningful and accessible for students (An, Ma, & Capraro, 2011; Cornett, 2007).

Conceptual Framework

Self- and Peer Evaluation As an Instructional Method

As one of the key components within education for monitoring students' progress, evaluation has been an emphasis in almost all teacher education programs and utilized by teachers at all grade levels (Kennedy, Chan, Fok, & Yu, 2008). In contrast with traditional classroom evaluation approaches administrated by instructors via processes that are comparatively passive, peer evaluation can be integrated with more active learning approaches, providing students opportunities to be involved in their own assessment process (Shepard, 2000). The experiences incurred while systematically reflecting on work created by oneself or one's peers can help students develop richer understanding of the content, as well as accountability (Liu, Lin, & Yuan, 2002; Topping, Smith, Swanson, & Elliot, 2000). Peer evaluation has also been used extensively within teacher education programs as a method to prepare their preservice educators for performing classroom assessment (Buchanan & Stern, 2012; Tsai & Liang, 2009; Wen & Tsai, 2008).

Two interrelated viewpoints for understanding the benefits of peer review have been recognized: (a) Pedagogically, peer review allows students to take more active roles in assessing their own mastery of mathematical knowledge, helping them to identify both their strengths as well as weaknesses; and (b) cognitively, peer review facilitates students in establishing self-explanations and critical thinking competencies (Davies, 2006; Fallows & Chandramohan, 2001). When well designed, peer evaluation allows

students to communicate their ideas and share constructive comments based on a formalized approach, which in turn requires students to spend more time concentrating on assessing mathematical tasks (Bernstein, 2008). Furthermore, researchers have also identified that students feel more comfortable accepting feedback from their classmates rather than their instructors (Buchanan, 2012); in particular, peer review experiences have facilitated students in achieving insightful comparisons between their peers' work with their own, providing them with sense-making feedback (van den Berg, Admiraal, & Pilot, 2006).

Instructional Design as a Pedagogical Ability

Instructional design practice provides prospective teachers with a toolkit of pedagogical techniques for addressing learning objectives that connect the intended curriculum (e.g., state-level standards) with the achieved curriculum (e.g., desired learning outcomes; Barab & Luehmann, 2003; Brown, 2009). Proficiency with developing student-friendly instructional design is a fundamental capability that all preservice teachers should achieve before graduating from a teacher education program (Grossman & Thompson, 2004). However, many preservice and novice teachers are woefully underprepared for implementing high-quality instructional design in real-world classrooms (Forbes & Davis, 2010; Nicol & Crespo, 2006).

As evidence of a teacher's general pedagogical knowledge, the ability to create and utilize high-quality instructional design has been examined by researchers since at least the 1970s, particularly in the subject areas of mathematics and science (Blömeke et al., 2008; Ozcinar, 2009). In general, teacher education programs prepare future elementary teachers to perform as generalists teaching multiple school subjects. Because so many primary school teacher education programs maintain such a broadly distributed subject areas emphasis, there can only be limited emphasis on developing subject-specific pedagogical content knowledge, including instructional design capacity (Anderson & Clark, 2012; Singham, 2003). Correspondingly, bilingual generalists have historically demonstrated more difficulties than their peers in achieving the design and implementation of subject-specific lessons in the STEM (science, technology, engineering, and mathematics) fields, partially because of the complexity of the mathematical symbols, theoretical concepts, and abstract processes involved (Cahnmann-Taylor, Souto-Manning, Wooten, & Dice, 2009).

Numerous empirical studies about teachers performing instructional design have been conducted, including comparisons between (a) preservice teachers and inservice teachers (An, Tillman, Shaheen, & Boren, 2014), (b) experienced teachers and novice teachers (Hogan, Rabinowitz, & Craven, 2003), (c) elementary teachers and secondary teachers (Kagan & Tippins, 1992), and (d) Chinese teachers and U.S. teachers (Cai & Wang, 2010). Yet, much remains to be understood about the differences between bilingual teachers who teach in two languages compared with monolingual teachers who teach only mathematics and science classroom curriculums in their native language.

Within the context described, the purpose of this current study was to reveal any differences between preservice teachers who were bilingual generalists compared with

monolingual generalists, in terms of their self- and peer evaluations of mathematics lessons that had been designed based on interdisciplinary themes. The following question guided the research:

Research Question : What differences were there between the monolingual generalists and the bilingual generalists in regard to judging their peers' instructional designs according to self-referenced criterion?

Method

Participants and Settings

The data collection took place at a research university in a predominantly bilingual southwestern metropolitan area in the United States. Approximately 23,000 students are currently enrolled at this university, and more than 75% of the undergraduate student body is Hispanic, which represents the highest percentage of Hispanic undergraduates among all universities in the United States. The participants were 36 senior undergraduate preservice teachers (33 females; 3 males) pursuing an elementary education degree and teacher certification in one of two areas (a) EC-6 generalist and (b) Early childhood to six grade [EC-6] bilingual generalist. Demographic data collected from the participants indicated a majority of participants (89%) self-reported as Hispanics.

Two groups of preservice teachers participated in the current study included (a) senior undergraduate students (n = 19) enrolled in the elementary regular (monolingual) generalist certificate program who planned to become elementary teachers using English as the language of instruction and (b) senior undergraduate students (n = 17) enrolled in the elementary bilingual generalist certificate program who planned to teach all subjects in both English and Spanish. The two groups of preservice teachers in the current study were intermixed during all activities.

Instrument, Data Collection, and Data Analysis

Data collected during the current study included (a) surveys containing peer evaluations of the instructional designs created by their classmates and themselves and (b) open-ended questionnaires wherein the participants reflected about the peer-evaluation process. All participants developed a brief mathematics curriculum containing a series of five interdisciplinary-themed lessons. Each preservice teacher also prepared a presentation for the whole class based on their interdisciplinary instructional designs, and during the demonstration explained their interdisciplinary themes and methods with demonstrations of at least one sample activity. After reviewing each instructional design and interacting with the presenters via a question-and-answer format, participants completed a peer-evaluation survey comparing the quality of the mathematics instructional design with the curriculum that they themselves had designed. In total, 36 preservice teacher participants each performed a peer evaluation of the 35

instructional designs that were presented (one participant performed the peer evaluations but did not complete the instructional design assignment); thus, 1,260 peer-evaluation surveys were collected.

Peer-evaluation task. The peer-evaluation survey was created by choosing appropriate themes and then revising them to be more specifically orientated toward assessing interdisciplinary mathematics pedagogy, based on modeling of items from professional instrumentation developed to assess quality of instructional designs (i.e., Beyer & Davis, 2012; Ding & Carlson, 2013). The self-referenced peer-evaluation survey that participants completed began with instructions to "compare each of the posters with your own poster based on the following criteria for each question." The individual instructions were followed by an explanation of the scoring system, detailing that for each of the Likert-type items on the survey the available responses included one of the following five scoring options such as (a) the lessons are far poorer in quality than your own lessons, (b) the lessons are poorer in quality than your own lessons, (c) the lessons are the same in quality as your own lessons, (d) the lessons are better in quality than your own lessons, and (e) the lessons are far better in quality than your own lessons. Five desirable characteristics of high-quality instructional designs were proposed for the participating preservice teachers to evaluate including (a) whether the lessons creatively demonstrated different ways for teaching math, (b) whether the lessons could effectively engage and motivate students to learn math, (c) whether the lessons could help students to understand math through alternative ways, (d) whether there were logical reasons for the order of the lessons and whether or not the five lessons had a coherent theme, and (e) whether the lessons could support bilingual students learning mathematics.

Self-reflection of peer-evaluation experience. After the collection of the peer evaluations discussed in the previous paragraph was completed, the 36 preservice teacher participants were invited to partake in the follow-up qualitative inquiry processes. These open-response inquiry prompts asked participants to address the following four topics based on their peer-evaluation experiences: (a) Describe the similarities between your lessons and your classmates' lessons in terms of opportunities for students to engage with and understand mathematics, (b) describe the differences between your lessons and your classmates' lessons in terms of opportunities for students to engage with and understand mathematics, (c) provide reasons with examples for your judgment of why some of your classmates' lessons are poorer than yours, (d) provide reasons with examples for your judgment of why some of your classmates' lessons are better than yours, and (e) what is your view about teaching mathematics through interdisciplinary strategies? In total, 95 pieces of individual reflection were collected from the monolingual generalists, and 85 pieces of individual reflection were collected from the bilingual generalists.

Data analysis. Independent *t* tests were undertaken to quantitatively establish any statistically significant differences in mean scores and standard deviations of the

peer-evaluation scores from those completing the regular generalist degree versus those completing the bilingual generalist certificate options. Effect sizes utilizing Cohen's *d* were also calculated as gauges of practical significance between the two groups. To assist qualitative analysis of the preservice teachers' perceptions regarding their experiences, data analysis used a grounded theory approach using systematic and flexible qualitative data analysis framework with the goal of developing concepts and models grounded in the existing data (Charmaz, 2006). Within a grounded theory approach, the data coding method used was the constant comparative method, wherein (a) qualitative data were compared case by case while generating flexible categories and integrating additional cases into the categorization scheme, (b) the qualitative data categorization was then refined based on responses to check the orientation that each piece of data indicated, and (c) once the meta categories were determined and the subsets saturated, the remaining qualitative data were coded utilizing those categories that had been previously developed by the research team (Glaser, 1978).

Results

Quantitative Findings

The results of an independent *t* test comparing the differences in judging their peer's instructional designs indicated that the monolingual generalists had statistically significantly lower scores than the bilingual generalists in all five evaluation aspects (see Table 1). Specifically, statistically significant differences were found between monolingual generalists and bilingual generalists as follows: (a) *The lessons creatively demonstrated different ways of teaching math*, with a p value of less than .001 and with a small-medium effect size ($d = 0.29$); (b) *the lessons can effectively engage and motivate students to learn math*, with a p value of less than .001 and with a small-medium effect size ($d = 0.29$); (c) *the lessons can help students to understand math through alternative ways*, with a p value of less than .001 and with a small-medium effect size ($d = 0.35$); (d) *there are logical reasons for the order of the lessons, and the five lessons had coherent themes*, with a p value of less than .001 and with a small-medium effect size ($d = 0.35$); and (e) *the lessons can support bilingual students learning mathematics*, with a p value of less than .001 and with a medium effect size ($d = 0.41$).

Qualitative Findings

To qualitatively explore the differences between monolingual generalists and bilingual generalists in judging their peers' instructional designs, a total of four evaluation criteria categories with 21 specified themes emerged from the data (see Table 2), based on the 180 individual reflections that were analyzed. Within the self-reflections, each of the participants discussed the criteria that they used in their peer curriculum review processes. In general, both monolingual generalists and bilingual generalists evaluated the quality of effective interdisciplinary instructional designs based on multiple identified criteria. There were several similarities in the evaluation criteria chosen by both

Table 1. Comparison of Self-Referenced Peer-Evaluation Scores Between Monolingual Generalists [MG] and Bilingual Generalists [BG].

Evaluation aspects	Groups	*M* (*SD*)	*p* value (*t* value)	Effect size (Cohen's *d*)
The lessons creatively demonstrated different ways of teaching math	MG (*n* = 665) BG (*n* = 595)	2.94 (0.79) 3.17 (0.82)	<.001 (4.994)	0.29
The lessons can effectively engage and motivate students to learn math	MG (*n* = 665) BG (*n* = 595)	2.91 (0.72) 3.12 (0.72)	<.001 (5.189)	0.29
The lessons can help students to understand math through alternative ways	MG (*n* = 665) BG (*n* = 595)	2.89 (0.75) 3.15 (0.74)	<.001 (6.052)	0.35
There are logical reasons for the order of the lessons, and the five lessons had coherent themes	MG (*n* = 665) BG (*n* = 595)	2.88 (0.60) 3.10 (0.67)	<.001 (6.076)	0.35
The lessons can support bilingual students learning mathematics	MG (*n* = 665) BG (*n* = 595)	2.86 (0.56) 3.12 (0.70)	<.001 (7.302)	0.41

groups of teachers. Specifically, most of the monolingual generalists and bilingual generalists utilized the three factors of (a) *curriculum structure*, (b) *lesson foci*, and (c) *pedagogical connections*, as their foremost evaluation criteria during the peer-evaluation process. Likewise, several differences regarding evaluation foci were also found within both the general and specific criteria used by the two groups of preservice teachers. The monolingual generalists tended to use a more multifaceted evaluation system in their evaluation process. Compared with each bilingual generalist who used 2.7 criteria on average in their peer-evaluation process, each monolingual generalist used 3.2 criteria during the same process. In addition, the bilingual generalists were more prone to propose *differentiated instruction* as one of the major evaluation criteria than were the monolingual generalists, whereas the monolingual generalists were more prone to propose *opportunities to explore mathematics* as one of the major evaluation criteria than were the bilingual generalists.

Pedagogical connections. Similar rates of responses per participant were found between monolingual generalists (0.77) and bilingual generalists (0.71) in regard to their referencing *pedagogical connections* as an evaluation criteria. However, the two groups of teachers demonstrated different foci regarding the specific types of connections used while evaluating their peers' instructional designs. The monolingual generalists paid more attention to internal connections within the mathematics curriculum and the methods used for conceptualizing mathematics topics; the bilingual generalists paid more attention to the connections established between mathematics and other school

Table 2. Monolingual Generalists [MG] and Bilingual Generalists' [BG] Evaluation Foci for Interdisciplinary-Themed Mathematics Instructional Design.

		MG (n = 95)		BG (n = 85)	
General criteria	Specified evaluation criteria	Response counts	Response per participant	Response counts[a]	Response per participant
Pedagogical connections	Target math topics are meaningfully connected with other math concepts	25	(0.77)	8	(0.71)
	Target math topics are meaningfully connected with nonmath concepts	12		23	
	Target math topics are contextualized through multiple themes	6		14	
	Target math topics are conceptualized through multiple approaches	13		2	
	Allows students to apply target math topics in real-world scenarios	18		5	
Curriculum structure and lesson foci	The lesson design is appropriate for students' age/grade	12	(1.12)	14	(0.87)
	The lessons match curriculum standards	24		6	
	Activities built on each other from start to finish in each lesson	17		8	
	There are logical reasons for the order of the lessons	28		22	
	The lessons have coherent interdisciplinary themes	9		19	
	The lessons have progressive mathematics foci	16		5	
Differentiated instruction	Special activities were prepared for bilingual/ELL students	5	(0.46)	38	(0.80)
	Special activities were prepared for gifted students	12		9	

(continued)

Table 2. (continued)

General criteria	Specified evaluation criteria	MG (n = 95) Response counts	MG (n = 95) Response per participant	BG (n = 85) Response counts[a]	BG (n = 85) Response per participant
	The lesson utilized multiple instructional approaches (e.g., group discussion)	13		7	
	Activities match students' cultural backgrounds	0		12	
	Uses different methods to assess student understanding	14		2	
Opportunities to explore mathematics	Students have opportunities for self-directed learning	16	(0.85)	7	(0.36)
	Students have opportunities to reflect on their own learning	12		2	
	The lesson provided various nondrill activities	22		17	
	Students can choose their own way to solve math problems	18		2	
	The lesson provides challenges that activate students' higher order thinking	13		3	
Total response counts (total responses per participant)		305	(3.21)	225	(2.68)

Note. Response counts were computed based on the number of new themes that emerged from participants' total writing pieces, and responses per participant were computed based on the ratio between the total number of new themes and the number of their total writing pieces. ELL = English language learner.

subjects as well as the contextualization methods. For example, one of the monolingual generalists, Jesse (all names are pseudonyms), developed her mathematics lessons by integrating five different school subjects across a single mathematics topic, and she described the differences in structure among the lessons developed by herself and her classmates as follows:

> I noticed that around half of us created lessons with just the common thread of the lesson we created while others actually took the time to add another element of thematic

> cohesion. Some projects had math at the center and encompassed many other contents such as science, language arts, music, visual arts, health, and others. Others did not put math at the center; rather, math was one of the many contents that related to the subject in the center of the structure. Yet others only used two contents in their projects, like mine. However, even among those the contents used were varied. I feel like focusing on one math concept throughout the lessons would make it easier for students to understand the math material.

Curriculum structure and lesson foci. As the most prevalent theme across both groups of teachers, this criterion had a rate of response per participant of 1.12 among monolingual generalists and 0.87 among bilingual generalists. Most of the participants agreed that effective interdisciplinary mathematics instructional designs should have (a) coherent mathematics themes and a logical rationale for the ordering of the lessons and (b) the lessons should be age-appropriate to meet students' needs, both cognitively and behaviorally. There were also differences found between the two groups of teachers. For example, the monolingual generalists were more prone to mention that the lessons created by their peers should have a structured progression of mathematics foci, whereas the bilingual generalists were more prone to emphasize that the series of lessons should have a prominent and coherent interdisciplinary theme. As an illustration, one of the bilingual generalists, Claudia, developed her interdisciplinary mathematics lessons by integrating language arts as an interdisciplinary theme within five different mathematics content areas (number and operation, algebra, measurement, geometry, and data analysis and probability). While contemplating the comparative strengths and weaknesses between the lessons developed based on these two different priorities, Claudia made the following comment:

> The way I did it I feel it is fun because the students get to experience different activities with different [mathematics] topics but they can get confused. Some of the differences that I noticed between my classmates and me were that some of them just stuck to one theme in their lesson and that theme was linked to all the lessons. I realized this was the correct way in doing our project as this allowed for an easy progression of lessons, and rather than just having five lessons that somewhat went together in which students may get confused while interchanging from one activity to the other. For me it was easier in a way to pick just one math concept and apply the interdisciplinary contents to that [mathematics] concept, students are able to adapt their knowledge by built [building?] upon the knowledge they got from the previous lessons.

Differentiated instruction. Monolingual generalists and bilingual generalists emphasized different criteria while evaluating the aspect of differentiated instruction. During their evaluation process, the bilingual generalists tended to emphasize their concerns about whether the instructional designs addressed the fundamental principles of bilingual education and culturally responsive teaching, whereas the monolingual generalists tended to emphasize their concerns about whether the instructional designs covered the content thoroughly. Ana, a bilingual generalist, explained how an interdisciplinary teaching strategy can benefit bilingual students via engaging culturally themed lessons:

> Using Interdisciplinary activities is just a great modification strategy to try implementing with bilingual students. If a concept is not being well understand, connecting it with another subject it might help the students have a better understanding of it. Bilingual students have a hard time learning the language as it is, so trying to make it easier for them it should be one of any teacher's priorities. They need to develop a way [where] teachers get to do interdisciplinary units all year around, and make like research to see how helpful it is to help your bilingual students. If we want for them to succeed we need to do a little more for them to try to connect the content to them. For example, here in El Paso we could select themes such as the Mexican American culture or the border since a majority of the El Paso area are Mexican American. When we design lessons, we need to keep both ethnicities and cultures in consideration when developing an interdisciplinary unit.

Opportunities to explore mathematics. Qualitative analysis results indicated that monolingual generalists had an overall higher response per participant than their bilingual generalist peers in all specified evaluation criteria pertaining to opportunities for exploring mathematics. In particular, monolingual generalists concentrated their peer evaluations on whether or not the interdisciplinary-themed mathematics lessons provided student-centered learning opportunities to discover and reflect upon mathematics within a constructivist framework. Monolingual generalists also paid more attention to whether their peers, within their instructional designs, provided mathematics learning-tasks that could engage students in analysis, synthesis, and opportunities to creatively engage with mathematical concepts and ideas. For example, one of the monolingual generalists expressed her perspective on why one of her classmates' lessons was inferior to her own due to its presenting comparatively limited opportunities to authentically explore mathematics:

> From the sets of lessons that I evaluated I think the one titled "Let's climb the highest Mountains" was one of the sets of lessons that is worse than me. I really did not saw any hands on activities; it was the same thing I saw when I was younger, boring and more boring math. I think that she could have been a little bit more creative with her lessons as well as being a little bit more challenging. There are so many questions and activities that she would have been able to apply in order to make it fun and interesting. For example, instead of researching the height of mountains, she can ask her students where are they located? How old each mountain is? What are the differences on the mountains? Are the shapes different? What do you think affects the mountains? Why do you think that?

Discussion

This study was performed with the intention of expanding upon the body of empirical research analyzing preservice elementary teachers' capacity for contextualizing STEM education within engaging interdisciplinary contexts (Sluijsmans, Brand-Gruwel, van Merriënboer, & Bastiaens, 2002; Wen & Tsai, 2008). The results obtained from the current study provided several insights into how preservice monolingual generalists and bilingual generalists differed when judging their peers' instructional designs for interdisciplinary-themed mathematics pedagogy. The findings from the current study

assist in identifying and illustrating preservice elementary teachers' instructional design self-efficacy via the results they provided during the peer-evaluation process.

It has previously been established that many preservice teachers are not properly prepared to constructively critique curriculum materials such as lesson plans (Forbes & Davis, 2010; Lloyd & Behm, 2005). To address this problem, the current study piloted an alternative approach for supporting preservice teachers in learning a variety of interdisciplinary pedagogical design templates as they developed their own lessons and then reviewed each other's lessons. The feedback that each preservice teacher generated and received was designed to expand their views of how mathematics lessons can be integrated with interdisciplinary themes, while also challenging them to constructively critique the quality of lessons developed by their peers.

The results obtained from this study provide evidence that bilingual generalists, when evaluating their classmates' instructional designs, tend to give higher scores than their peers that are monolingual generalists. This indicates that the participating monolingual generalists had higher expectations than the bilingual generalists in all five evaluation aspects. Specifically, the monolingual generalists believed their peers' instructional designs were overall worse than their own, whereas the bilingual generalists overall believed their peer's instructional designs were better than their own. These prominent differences in overall peer-evaluation results reflect the apparent fact that the bilingual generalists had lower self-efficacy in their interdisciplinary-themed mathematics instructional designs than their monolingual generalists peers. This difference might be explained by recognizing that the bilingual generalists' self-efficacy toward mathematics education occurs within the context of dual language communication requiring decoding of mathematical symbols and abstract concepts through linguistic approaches that involve language switching (Cowan & Albers, 2006).

The peer-evaluation outcomes as well as the qualitative reflection results collectively provide insight into how and why the two groups of preservice teachers differed in their self-efficacy for developing interdisciplinary-themed mathematics lessons. Compared with the monolingual generalists, when designing and implementing interdisciplinary-themed mathematics lessons, the bilingual generalists appear to place higher emphasis upon affective aspects of the lessons instead of cognitive considerations. This can be partially explained by the fact that the monolingual generalists tended to have more evaluation criteria than the bilingual generalists. On average, each monolingual generalist reported using 3.2 specific evaluation criteria, while each bilingual generalist reported using 2.7 specific criteria in their peer-evaluation process. The higher number of evaluation criteria per participant is one of the reasons why monolingual generalists had lower evaluation scores when they reviewed their classmates' lesson designs. The number of evaluation criteria indirectly affected the scores that preservice teachers gave for their peers, as having more foci for evaluation resulted in correspondingly more identification of limitations.

By considering preservice teachers' proficiency in critiquing mathematics instructional designs, the current study provided an opportunity for examining self-referenced peer evaluations as a learning opportunity for preservice teachers. The results from this study indicate that self-referenced peer evaluations should be recognized as

a pedagogical mechanism for developing meaningful mathematics teaching strategies that help future teachers obtain insight and understanding of high-quality instructional design. Structuring the process of evaluating the strengths and weaknesses of individual pedagogical components based on a suitable variety of criterion can facilitate this agenda. Within this context, the present study provided evidence that preservice teachers' self-efficacy is correlated to whether they will have singular or dual language teaching responsibilities.

Specifically, the current study determined that preservice bilingual generalists tended to give their peers higher scores than themselves during instructional design evaluations, believing most of their classmates' instructional designs were better than their own; in contrast, the regular generalists tended to give their peers lower scores than themselves during instructional design evaluations, believing most of their classmates' instructional designs were inferior to their own. This finding confirms that bilingual teachers would benefit from receiving additional opportunities to develop positive and robust STEM teaching self-efficacy, possibly by participating in and critically reviewing further activities that link subject matter pedagogy with meaningful and accessible interdisciplinary contexts (An et al., 2014; Gresham, 2008; Vinson, 2001).

The current study provided further discernment into how preservice teacher educators might use peer evaluation as a pedagogical method during teacher preparation. The practice of peer evaluation focusing upon interdisciplinary-themed instructional designs can help preservice teachers understand why particular pedagogical approaches may lead to ineffective mathematics teaching. Examples identified during the current study included (a) failing to provide meaningful pedagogical connections between and within mathematics topics, (b) lessons not following a logical sequence, or (c) not offering students differentiated instruction. The current study also provided a perspective on how to use self-referenced peer evaluations as an alternative method for assessing preservice teachers' self-efficacy.

Conclusion

Before proceeding to summative conclusions, some limitations to the current research study should be noted. First, this study was conducted within a college of education and all participants were education majors and therefore not necessarily representative of noneducation majors. Second, similar to the broader demographics of the college of education within which this study was conducted, the majority of students who participated in this study were female, and thus results are not necessarily generalizable to male students who did not participate in the study. To address these two limitations, future research is needed to replicate the current study with a larger and more diversified demographic of participants, including male students, as well as students from local high schools and community colleges.

Another limitation is that the preservice bilingual generalists in this study were dissimilar from the majority of preservice bilingual generalists nationally in that most of such students are native English speakers using Spanish as a second language to teach elementary subjects, whereas many of the study participants were native Spanish

speakers using English as a second language. Furthermore, many of the bilingual generalist participants in this study were international students who traveled across the border between México and the United States to participate in the study. Therefore, it should be recognized that the quantitative findings from this study may not be generalizable to populations that do not reside within a similar urban geographic area on the United States–México border.

The primary goal of this research study was to examine potential methods and opportunities for facilitating preservice teachers in developing and using interdisciplinary-themed mathematics pedagogy. The differences that were noted in this study between the monolingual generalists and bilingual generalists should not be misinterpreted as indicators that one group of teachers is better than the other group in their instructional design capacities. Evidence indicated that the two groups of teachers were dissimilar in several ways during the peer evaluations in how they created rubrics and how they developed their peer-evaluation rationale. The differences between bilingual generalists and monolingual generalists while designing and evaluating STEM lessons displayed within the current study, as well as several prior studies (e.g., J. A. Cooper & Schleser, 2006; Saalbach et al., 2013), illustrate the need for providing differentiated teacher preparation activities for preservice bilingual teachers based on their unique pedagogical, cognitive, and linguistic requirements.

Improving the quality of teacher education programs has been recognized as essential for closing the achievement gap between minority and nonminority students (The Education Alliance, 2006). Teachers who are capable of teaching school subjects in both English and Spanish are one of the key factors for ensuring bilingual students receive equitable education lacking language barriers. Yet, many teacher education programs fail to provide experiences for preservice bilingual teachers that instill the use of differentiated pedagogical approaches (Gresham, 2008; Knoblauch & Hoy, 2008). The current study was designed to support the achievement of a deeper understanding of the differences between the numerous teacher educator demographics. Specifically, this study aimed to help identify some of the key differences between monolingual generalists and bilingual generalists, especially in regard to their self-efficacy at interdisciplinary-themed instructional designs of mathematics pedagogy. The findings from this study encourage further investigations into developing customized pedagogical methods for teacher education of our future bilingual educators, a crucial resource in our striving to close the academic achievement gap nationally and internationally.

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