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A Comparative Analysis of the Relationship among Quality Instruction, Teacher Self-efficacy, Student Background, and Mathematics Achievement in South Korea and the United States

Ji-Won Son, Seong Won Han & Chungseo Kang
University at Buffalo–The State University of New York, USA
Oh Nam Kwon
Seoul National University, SOUTH KOREA

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The purpose of this study is to compare and contrast student, teacher, and school factors that are associated with student mathematics achievement in South Korea and the United States. Using the data from the Trends in International Mathematics and Science Study (TIMSS) 2011, this study examines factors that are linked to teachers who deliver quality instruction with high self-efficacy in both countries. We also investigate the association between teachers with high-quality instruction and high self-efficacy and 8th graders' mathematics achievement. It was found that teachers' perceived academic emphasis was commonly associated with teachers who claimed to provide high-quality mathematics instruction with high self-efficacy. However, the two countries' results differed in the association between teachers' opportunities to learn in professional development programs and high-quality instruction with high self-efficacy. Implications from this study suggest that the quality and training of teachers and students' gender gap in achievement are significant issues.

Keywords: TIMSS, self-efficacy, quality instruction, mathematics achievement, comparative study

INTRODUCTION

The purpose of this study is to compare and contrast student, classroom (teacher), and school factors that are associated with mathematics achievement of

Correspondence: Ji-Won Son,
Learning and Instruction/ University at Buffalo–The State University of New York, 569 Baldy Hall, University at Buffalo, Buffalo, NY, 14260, USA.
E-mail: jiwonson@buffalo.edu

secondary school students in South Korea and the United States. Students' mathematics achievement is often associated with the future economic power and competitiveness of a country. Accordingly, understanding and identifying factors that may have a meaningful and consistent relationship with mathematics achievement has been of great interest to policymakers and educators in South Korea but also all around the world including the United States.

During the last 20 years, large-scale international assessment studies of mathematics, including the Trends in International Mathematics and Science Study (TIMSS) 1995, 1999, 2003, 2007, 2011, and the Program for International Student Assessment (PISA) 2003 to 2012 have provided an opportunity to analyze the important factors that are linked to student achievement and have allowed researchers to identify strengths and weaknesses in our mathematics education (Wagemaker, 2003). Researchers have identified multiple variables that have an impact on student learning including: family background and socio-economic status (Brese & Mirazchiyski, 2010), peer influence (Kupari, 2006), gender differences (Else-Quest, Hyde, & Linn, 2010; Guiso, Monte, Sapienza, & Zingales, 2008), and personal characteristics (Chiu & Klassen, 2010). However, growing evidence shows that teacher quality is a crucial contributor to student learning. Regardless of the initial academic level of students, highly effective teachers, and consequently high-quality teaching, can make a difference in promoting student achievement (Carpenter, Ramirez, & Severn, 2006; Sanders & Rivers, 1996). Ball (1999) also highlights that effective teachers have the combination of three important components: teacher knowledge, pedagogical skills, and dispositions resulting in a strong sense of self-efficacy (Betoret, 2006; Klassen & Chiu, 2010).

State of the literature

- Quality teaching includes not only an individual's knowledge, but also an individual's ability to act with intention.
- Teachers' sense of efficacy – their belief in their ability as teachers to help students thrive – contributes to student learning.
- Although a significant body of research has identified factors that influence students' mathematics achievement, teachers' self-efficacy was not considered in the analysis of TIMSS data.

Contribution of this paper to the literature

- There is a significant positive association between teachers' mathematics instruction and self-efficacy typology and students' mathematics achievement in the United States, but not in South Korea.
- Teachers' years of experience and several student background characteristics, such as parents' level of education and the number of books at home, were positively associated with students' mathematics achievement in both countries.
- However, the two countries' results differed in the association between teachers' opportunities to learn in professional development programs and teachers' quality instruction with high self-efficacy.

In this study, we hypothesize that teacher self-efficacy is a basis for creating quality instruction where teachers promote students' higher-order thinking in mathematics. Quality teaching includes not only an individual's knowledge, but also an individual's strong self-belief in one's capability to act with intention. In particular, teachers' sense of efficacy – their belief in their own ability as teachers to organize and execute their teaching to help students thrive – contributes to student learning as well as their teaching motivation (Bandura, 1997; Henson, 2002). Although an emerging body of research shows that teacher self-efficacy is associated with students' motivation and achievement (Caprara, Barbaranelli, Steca, & Malone, 2006; Skaalvik & Skaalvik, 2007; Tschanne-Moran & Woolfolk Hoy, 2001), as well as teachers' job commitment and job satisfaction (Klassen & Chiu, 2010; Klassen, Bong, Usher, Chong, Huan, Wong, & Georgiou, 2009), little is known about the collective association of teacher self-efficacy and quality instruction with students' mathematics achievement or what factors characterize teachers who deliver quality instruction with high self-efficacy.

Based on the data collected on eighth-graders in TIMSS 2011, we examine the factors that are associated with mathematics achievement of secondary students in

South Korea and the United States. Because prior research highlights that effective teachers need to provide not only cognitively demanding instruction but also possess high self-efficacy (Cochran-Smith & Zeichner, 2005), we first examine the factors that distinguish teachers who provide quality instruction with high self-efficacy. We also investigate whether such teacher characteristics are significant factors associated with students' mathematics achievement. Finally, we examine the association between other teacher factors (e.g., years of experience, job satisfaction), school contexts (e.g., school safety), and student factors (e.g., gender, parents' education) that are related to students' mathematics achievement.

Pointing out a shortage of qualified mathematics teachers as a major concern in mathematics education in the United States, Akiba, LeTendre, and Scribner (2007) called for international comparative studies that look at how other countries such as South Korea have achieved excellence in the teacher workforce and what factors mediate the relationship between students' learning opportunities and achievement gaps. In response to this call, by comparing and contrasting student, teacher, and school factors that are associated with students' mathematics achievement in South Korea and the United States, we intend to provide suggestions to improve mathematics education in both countries. South Korea was chosen for the study for two primary reasons. First, Korea is clearly distinct from the United States in terms of various teaching conditions (i.e., centralized/decentralized educational system; teacher recruitment system; and teacher professional development policy) (Hofstede & Hofstede, 2005). Second, South Korea has been well-known as a country for high-quality teachers, and is one of the top-tier countries for high mathematics scores in international assessments (Park, 2004). Given the high-quality of mathematics teachers and resulting high level of student achievement in South Korea, comparing student, teacher, and school factors that are associated with student achievement across two countries would provide some insight for policymakers, school administrators, teacher educators, including profession development experts who attempt to find better ways to improve student mathematics achievement and quality instruction in both countries. Although South Korea has been praised by the international community for performance on international academic achievement tests and the high-quality of its teaching workforce, there is a room for improvement. This comparative study can help South Korea to identify challenges for educational policies from an international perspective. Research questions that guided this study are:

1. What factors are associated with teachers who provide quality instruction with high self-efficacy (that is, mathematics instruction and teacher self-efficacy typology) in South Korea and the United States?
2. To what extent is mathematics instruction and teacher self-efficacy typology associated with students' mathematics scores, after controlling for student backgrounds, other teacher characteristics, and school contexts in South Korea and the United States?
3. Is there any difference in regard to the factors that are associated with student mathematics achievement in South Korea and the United States?

THEORETICAL BACKGROUND

The process of learning and teaching

Learning and teaching processes take place in the classroom, and thus are situated in school (Mullis et al., 2005). The conceptual basis of this study, shown in Figure 1, was adapted from Shavelson, McDonnell, Oakes, Carey, and Picus (1987) and served as a guide in selecting the factors in this study. The model contains three main components – inputs, processes, and outputs – which correspond to three

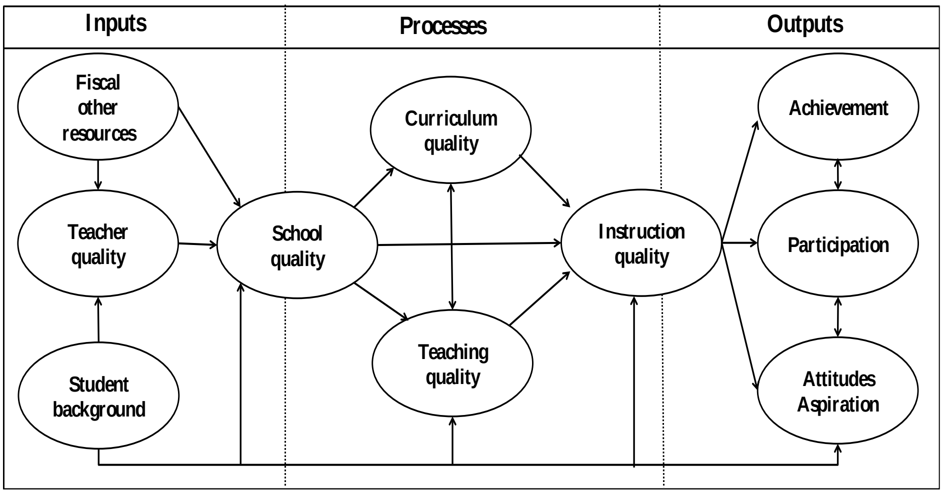

Figure 1. Conceptual basis for the learning and teaching process

distinguishable levels: school, classroom (teacher), and student levels. The *inputs* factors refer to the human and financial resources available to education at national, state, and school levels. These factors are directly associated with the teaching and learning *processes* of teachers, such as what is taught and how it is taught, which directly have an effect on the *outputs,* the consequences of schooling on students from different backgrounds. The domain of outcomes includes: (1) students' achievement, (2) students' participation in mathematical activities within and outside of school, and (3) students' attitudes toward mathematics and aspirations with regard to studying mathematics and pursuing mathematics-related occupations.

As shown in Figure 1, there are many factors which have either a direct or an indirect influence on students' achievement. For example, students' background at the inputs stage directly associate with teachers' quality, teaching quality, and instructional quality in the *processes* stage (Ghagar, Najib, Othman, & Mohammadpour, 2011). In addition, teachers' decisions regarding what topics to cover, grading policy, and methods of presenting material can influence instruction quality (Son & Kim, 2015). However, it is not possible to consider all of these existing factors in one study. Thus, based on the extensive empirical research regarding the previous TIMSS data (e.g., Bos & Kuiper, 1999; Howie & Plomp, 2006) as well as other mathematics education-related research evidences, only a few factors from student, classroom (teacher), and school levels were selected to answer the research questions that intended to assess their association with student mathematics achievement (see Figure 2).

Prior studies on influential factors on student achievement

A significant body of research has identified factors that influence students' mathematics achievement. As described earlier, three levels of influence on student mathematics achievement were identified in prior research: (1) student-level factors (e.g., student's self-efficacy in mathematics, students' home background characteristics) (Kupari, 2006); (2) teacher or classroom-level factors (e.g., teachers' instructional approaches, knowledge, or self-efficacy) (Papanastasiou, 2008); and (3) contextual or school-level factors (e.g., the location of the school, the number of desks) (Creemers, 1994). Among the studies based on the international data, some highlight student factors as the major factor for predicting students' mathematics achievement (Kupari, 2006; Reezigt, Guldemond, & Creemers, 1999). For example, Kupari (2006), who analyzed the relationship between student, teacher, and school background factors and mathematics achievement based on the TIMSS 1999 data, reported that the students' self-concept in mathematics has a particularly strong (reciprocal) association with achievement. In a more recent study based on TIMSS 2007, Brese and Mirazchiyski (2010) also revealed the strong influence of student factors, in particular student home background characteristics, such as students' socioeconomic status and educational background of the family members, on students' performance.

On the other hand, the analysis of some of the TIMSS data revealed the strong influence of instructional practices implemented in mathematics classrooms on student performance. Among all the studies based on the international data sets, some have found direct or teacher-centered instruction more effective than the inquiry-based or student-centered one (Ceylan & Berberoglu, 2007; D'Agostino, 2000). In contrast, more have suggested that students' performance can be improved when the class is better organized and students are actively involved in the learning through student-centered activities (House, 2008; Van den Broeck, Van Damme, & Opdenakker, 2006). In particular, Papanastasiou (2008) documented that teachers' instruction focusing on student thinking affects students' achievement.

As one might recognize, one of the main findings from prior research based on the TIMSS data is that the proportion of the variance accounted for by student-, teacher-, and school-level differences varies across countries. For example, Park and Park (2006) found that in South Korea, about 4% of the total variance of mathematics achievement was attributed to school-level factors. In contrast, it was 55% for South African students (Howie, 2006). This insight calls for more research studies based on the TIMSS data. In addition, although teacher self-efficacy can be a good indicator of quality teaching, only a few research studies examine the impact of teacher self-efficacy on students' mathematics achievement. Quality teaching is multi-faceted. Quality teaching includes not only individuals' knowledge, but also individuals' sense of efficacy – their belief in their own ability as teachers to organize and execute their teaching to help students learn (Bandura, 2006; Henson, 2002). According to Bandura (1990), the stronger the perceived self-efficacy, the more likely teachers are to adopt the recommended practice. Similarly, Skaalvik and Skaalvik (2007) show that teacher self-efficacy influences teaching behaviors and students' motivation and achievement. Teachers with low self-efficacy experience greater difficulties in teaching, higher levels of job-related stress (Betoret, 2006), and lower levels of job satisfaction (Klassen et al., 2009). However, a few studies considered this factor in the analysis of TIMSS data (Betoret, 2006; Klassen, et al., 2009). In spite of the evident association between teacher self-efficacy and student and teacher outcomes, little is known about how teacher self-efficacy and quality instruction are collectively related to students' mathematics achievement.

This study intended to minimize these gaps by examining if teachers' instruction and teachers' self-efficacy typology is associated with students' mathematics achievement. In addition, we explored to what extent teacher mathematics instruction and self-efficacy is associated with students' mathematics scores, after controlling for student backgrounds, other teacher factors, and school factors in South Korea and the United States. We hypothesized that, in addition to teacher mathematics instruction and self-efficacy, school contexts (working conditions, principal's academic emphasis, school safety, and job satisfaction), teacher characteristics (major, years of teaching experience, gender, and professional development opportunities), and student background (parents' education, educational aspiration of students, gender, race, and the number of books at home) are associated with students' mathematics achievement (see Figure 2). In the next section, the selected factors at the three levels are discussed in detail.

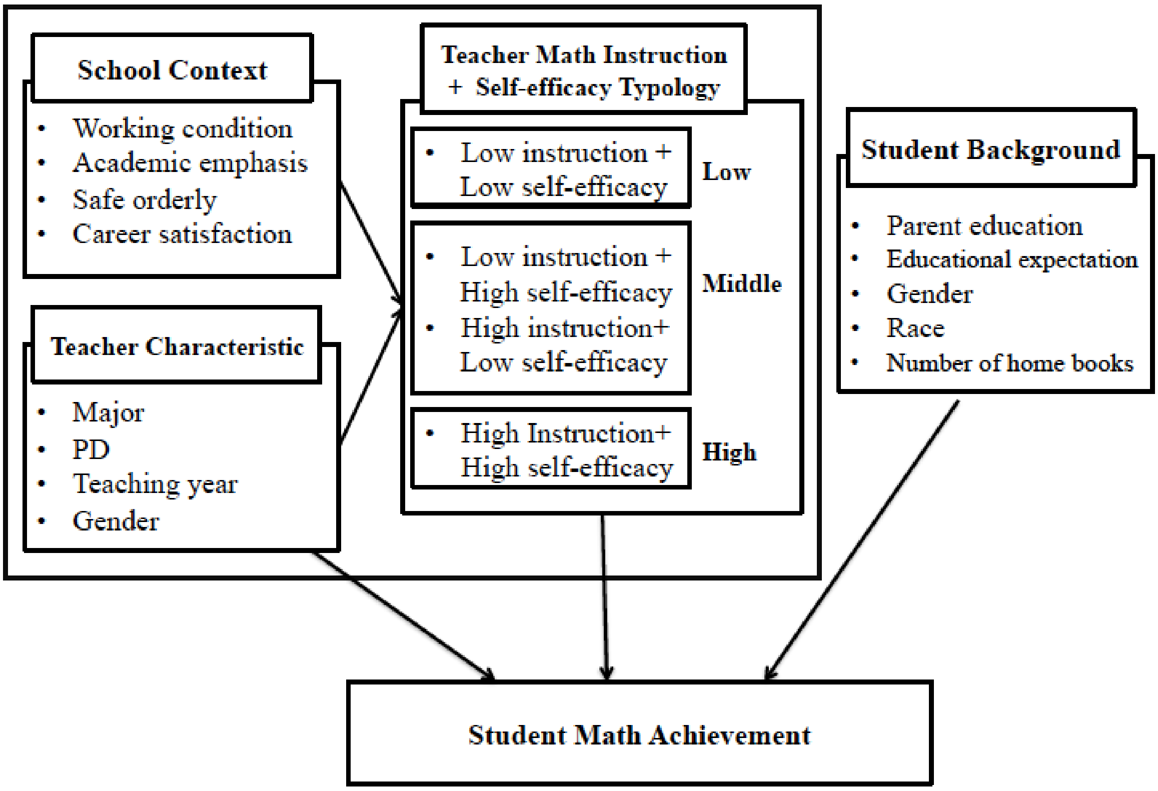

Figure 2. Conceptual framework for the study

METHODOLOGY

Data

This study used data from TIMSS 2011. Conducted on a regular 4-year cycle, TIMSS has assessed mathematics and science at the fourth and eighth grades since 1995. This study focused on eighth graders, their mathematics teachers, classrooms, and schools in South Korea and the United States. Note that the teacher sample in TIMSS 2011 does not constitute a nationally representative sample of teachers, but rather it is a sample of the teachers who taught a representative sample of students in each nation. The sample sizes were 5,170 students and 375 teachers in Korea, and 10,445 students and 537 teachers in the United States.

Conceptual framework and measures

Figure 2 shows our conceptual framework for the study. The outcome measure for this study is students' mathematics achievement scores. Mathematics instruction and teacher self-efficacy typology is selected as an independent variable for the study. Teacher characteristic variables were teacher's major, gender, years of experience and professional development (PD) participation; student background variables including gender, race, number of books at home, parents' education, and students' educational aspiration. School context variables based on teachers' perceived collaboration, their perceived academic emphasis, perceived school safety, and their career satisfaction were selected as control variables for the study. Appendix A presents more detailed information about variables included in our analyses.

We tried to include the same background variables in models of both countries, however, two variables: race and teacher major, were considered differently. First, in the analysis of Korea, a race variable was excluded because Korea is well-known as an ethnically homogenous society (Kang, 2010). Second, given that the teaching qualification system for middle school mathematics teachers is different between South Korea and the United States, the teacher major was treated differently. For example, four categories were used to represent the teacher major in the United States, whereas two categories were used for Korean mathematics teachers. In the U.S. model, teacher major was classified into four categories including: (1) no major in education and math (reference group), (2) major in education but not mathematics, (3) major in mathematics but not in education, and (4) major in both education and mathematics. In contrast, Korean teachers were classified into two categories: (1) non-mathematics major (reference group), or (2) mathematics major. Because there are only a few teachers in the "no major in education and math" and "major in both mathematics and education" categories in Korea, we differentiated teachers by using only one dimension, their major in mathematics.

This study employed multiple imputations due to missing data on teacher and student background variables. Several studies highlighted the presence of systematic cross-cultural differences in response style on Likert-type psychological attitudinal data (Buckley, 2009; Chen, Lee, & Stevenson, 1995). Therefore, we created separate measures of attitudinal variables (i.e., teacher self-efficacy) in each country, indicating that a reference group for an individual teacher's response is fellow teachers in each country. We also estimated separate models by country and compared only the direction in the association between attitudinal variables and outcomes across countries. We did not compare the magnitude in this association. Table 1 presents descriptive statistics of the pooled imputed sample that was used in regression analyses. Note that only student achievement, PD participation hours, and school context variables are continuous and the rest of the variables are categorical. Thus, values in Table 1 represent either mean scores or percentages. For example, for teacher math instruction and self-efficacy typology, Table 1 shows that 32% of U.S. teachers were categorized in the low group, 39% were in the middle group, and 29% were in the high group. N in teacher characteristics and school context variables represents the total number of teachers in each country, whereas N in student characteristics represents the total number of students in each country.

Analysis

To answer the first research question, we first created a typology consisting of three different types of math teachers: (1) teachers with high-quality instruction and high self-efficacy (High group); (2) teachers with high-quality instruction but low self-efficacy or low-quality instruction but high self-efficacy (Middle group); and, (3) a teacher with low-quality instruction and low self-efficacy (Low group). The measure of mathematics instruction was derived from TIMSS 2011 items asking "*in teaching mathematics to this class, how often do you usually ask students to do the following*? (1) *explain their answers* (2) *relate what they are learning in mathematics to their daily lives* (3) *decide on their own procedure for solving complex problems*, and (4) *work on problems for which there is no immediately obvious method of solution.*" Participants in our study responded to these four items with a four-point Likert scale, anchored by 1 (never) and 4 (every or almost every lesson). This index was calculated via factor analysis with varimax rotation in each country (see Appendix 2 for details). Next, we classified teachers into two groups: (1) teachers with high-quality instruction (i.e., above the median) and (2) teachers with low-quality instruction (i.e., below the median). For instance, when a teacher's composite score is above the median, he or she was categorized as providing high-quality mathematics instruction. Otherwise, he or she was categorized as providing low-quality instruction.

Table 1. Descriptive statistics of variables used in regression analyses

	United States			Korea		
	N	Percent/ Mean	Std.	N	Percent/ Mean	Std.
Teacher math instruction and self-efficacy typology						
Low group (reference group)	537	32%	.46	375	48%	.46
Middle group	537	39%	.49	375	34%	.47
High group	537	29%	.45	375	18%	.38
Teacher characteristics						
Teacher Major (reference = no Edu, no Math)				(reference = no Math)		
Edu, no Math	537	24%	.43	-	-	-
Math, no Edu	537	17%	.37	375	51%	.50
Edu and Math	537	29%	.45	-	-	-
Teacher gender (reference = female)	537	30%	.46	375	29%	.45
PD participation	537	3	1.01	375	10	1.00
Teaching year	537	13.51	1.15	375	12.28	9.66
Student characteristics						
Math achievement	10,445	508.71	76.05	5,170	612.65	89.07
Parents' education (reference = elementary)						
Lower secondary	10,445	8%	.27	5,170	3%	.13
Upper secondary	10,445	25%	.43	5,170	40%	.49
Associate degree	10,445	10%	.30	5,170	8%	.27
BA, or above	10,445	54%	.50	5,170	50%	.50
Educational expectation (reference = finish primary)						
Finish lower secondary education	10,445	5%	.21	5,170	.3%	.18
Finish upper secondary education	10,445	2%	.14	-	0%	-
Finish an associate degree	10,445	2%	.14	5,170	11%	.31
Finish BA degree	10,445	43%	.50	5,170	56%	.50
Finish beyond BA degree	10,445	40%	.49	5,170	19%	.39
Gender (reference = female)	10,445	49%	.50	5,170	48%	.50
Race (reference = white)						
Black	10,445	12%	.33	-	-	-
Hispanic	10,445	26%	.44	-	-	-
Asian	10,445	5%	.21	-	-	-
Multiracial	10,445	5%	.22	-	-	-
Other	10,445	2%	.14	-	-	-
School contexts						
Working conditions	537	2.37	.68	375	1.55	.63
Perceived academic emphasis	537	1.76	.63	375	1.68	.60
Perceived school safety	537	2.43	.65	375	1.98	.49
Perceived career satisfaction	537	2.36	.65	375	1.89	.56

Note: For descriptive analysis, we utilized a normalized weight variable; total weight variable divided by the mean value of the total weight variable. The means of categorical variables indicate the ratio of correspondence variables in the total sample.

We acknowledge that the dichotomization of a continuous variable causes loss of information, but we dichotomized instructional practice composite scores in order to answer the intended research questions. As stated previously, we intended to identify factors that distinguish teachers who provide quality instruction with high self-efficacy from teachers with low-quality instruction and low self-efficacy and those with high-quality instruction and low self-efficacy. Thus, grouping and classification of teachers is a necessary condition in this study. In particular, our preliminary analyses show that the distribution of the mathematics instruction variable is negatively skewed in both countries. Thus, in order to use better estimates of teachers' instructional practices in categorizing teachers as those with either high-quality instruction or low-quality instruction, the median, a recommended criterion for classification (Hosmer & Lemeshow, 2004), was used. According to the categorization, around 49.6% and 50.4% of teachers in the United States are "low instruction teachers" and "high instruction teachers," respectively. In

South Korea, 51.2% and 48.9% of teachers are classified in the "low" and "high" groups, respectively.

Next, each teacher was again classified into two groups: teachers with high self-efficacy and those with low self-efficacy. The measure of teacher self-efficacy was derived from items asking "*in teaching mathematics to this class, how confident do you feel doing the following*: (1) *show students a variety of problem solving strategies*; (2) *provide challenging tasks for capable students*; (3) *adapt my teaching to engage students` interest*; and (4) *help students appreciate the value of learning mathematics*." We summed teachers' responses on these four items and then classified teachers into two groups: (1) teachers with high self-efficacy and (2) teacher with low self-efficacy. Similar to the mathematics instruction measure, in the preliminary descriptive analysis, we found that the distributions of teacher self-efficacy are negatively skewed in both of the United States and Korea dataset, indicating the mean value of self-efficacy is less than the median of it. This means that teachers in both countries tend to answer positively on the questions of self-efficacy. Thus, to minimize teachers' overestimation of their self-efficacy, teachers were categorized as possessing high self-efficacy when they reported the highest value for all four questions. If they reported other values to the four items, they were categorized as possessing low self-efficacy. After that, based on the classifications of mathematics instruction and teacher self-efficacy, teachers were classified into the aforementioned three groups (i.e., high group, middle group, and low group) in mathematics instruction and self-efficacy typology.

Then, in order to answer the second research question, we ran multinomial logistic regressions to examine the factors that are associated with teachers who provide quality instruction with high self-efficacy (that is, the 'high group' in the teacher mathematics instruction and self-efficacy typology). A multinomial logistic regression model allows us to "explain" variations in the odds of classifying teachers into either a high group or a middle group based on teacher-level factors (e.g., major and professional development participations) and school context factors (e.g., teachers' perceived academic emphasis on higher-level thinking and perceived school safety). The multinomial logistic regression model is as follows:

$$P_r(y_i = j) = \frac{\exp(X_i\beta_j)}{1 + \sum_{j=1}^{J}\exp(X_i\beta_j)}$$

where i denotes an individual teacher; j denotes three different categories of teacher math instruction and self-efficacy typology; y_i is the observed outcome; X_i is a matrix of explanatory variables; and β_j is a vector with the beta coefficient estimated. The observed outcome categories are the probability to be classified into the "middle group" (P_2) and the probability to be classified into the "high group" (P_3) with reference to be classified into the "low group" (P_1).

For the second research question concerning the degree to which mathematics instruction and teacher self-efficacy is associated with students' mathematics scores, after controlling for student backgrounds and other teacher factors and school contexts, we conducted *Ordinary Least-Squares (*OLS) regression analyses. We report clustered robust standard error, which adjusts the overestimated standard errors resulting from the violation of the independent errors assumption (Rogers, 1993). The OLS model is as follows:

$$S_i = \beta_0 + \beta_t X_i + \beta_c C_i + e$$

where S_i represents math achievement scores of an individual student i; X_i indicates a vector of a teacher's mathematics instruction and self-efficacy typology; C_i indicates a vector of students` individual backgrounds, math teacher characteristics, and school contexts related to an individual student i; and e is a random error term. We ran these multinomial logistic and OLS models separately by country to address the study's research questions. We also explored whether there were country differences in factors that are associated with student mathematics achievement in the United States and Korea to provide implications to mathematics education in both countries.

RESULTS

Table 2 presents the number of teachers categorized into the high group, the middle group, and the low group in math instruction and teacher self-efficacy typology in the United States and South Korea. In general, a large portion of teachers in both countries was categorized into either the low group, where teachers reported low self-efficacy and low-quality instruction, or the middle group, where teachers reported high self-efficacy but low-quality instruction or low self-efficacy but high-quality instruction.

Table 3 shows the features of quality instruction that are shared by teachers with high self-efficacy and those with low self-efficacy groups in the United States and South Korea. As mentioned previously, teachers were asked to indicate the presence of the four instructional approaches in their classroom as shown in Table 3, using a four-point Likert scale ranging from 1 (never) to 4 (every or almost every lesson).

Table 3 shows that teachers with high self-efficacy tended to rate higher presence for all four instructional features in their teaching than those with low self-efficacy in both countries. Among the four instructional features, teachers with high self-efficacy in both countries commonly reported that they asked students to explain their answers most often, followed by asking students to use their own procedure for solving complex problems and relating what they are learning in mathematics to their daily lives. This tendency suggests that teachers in the high self-efficacy group are likely to report the presence of recommended quality instruction more often than those in the low self-efficacy group in both countries.

Although teachers with high self-efficacy in the United States tended to rate higher for all four instructional features than those with high self-efficacy in South Korea, we are cautious to suggest which country's teachers show higher scores in teacher instruction practices due to the different culture and social context between

Table 2. Number of teachers in different groups in the United States and Korea

	High group	Middle group	Low group
	High self-efficacy + High-quality instruction	**High self-efficacy + low-quality instruction; low self-efficacy + high-quality instruction**	**Low self-efficacy + low-quality instruction**
United States (*n*=537)	29%	39%	32%
South Korea (*n*=375)	18%	34%	48%

Table 3. Teachers' instructional practice across different self-efficacy levels

Teacher Instruction	United States		South Korea	
	Mean	**SD**	**Mean**	**SD**
Low self-efficacy group				
Ask students to explain their answers	3.17	.79	2.65	.74
Ask students to relate math to daily life	2.41	.72	2.40	.66
Ask students to use their own procedure	2.23	.58	2.42	.80
Ask students to solve problems with no obvious solution	1.81	.52	2.27	.70
High self-efficacy group				
Ask students to explain their answer	3.85	.39	3.39	.66
Ask students to relate math to daily life	3.29	.68	3.16	.71
Ask students to use their own procedure	3.46	.57	3.19	.79
Ask students to solve problems with no obvious solution	2.89	.79	2.81	.88

*Note: **1**= Never, **2** = Some lessons, **3** = About half the lesson, **4** = Every or almost every lesson.*

the United States and Korea. Instead, we pinpoint that the values of standard deviation (SD) of all four features of quality instruction in South Korea are higher than those of United States, which indicates that responses from Korean teachers are more heterogeneous than those from U.S. teachers when reporting their instructional practices. Based on this understanding, we analyzed factors that are associated with teachers who provide quality instruction with high self-efficacy (that is, mathematics instruction and teacher self-efficacy typology) in South Korea and the United States.

Factors associated with teacher math instruction and self-efficacy typology

Table 4 shows the results from multinomial logistic regressions that predict factors associated with teachers who provide quality instruction with high self-efficacy. Odds ratio indicates the change in the odds of classifying into either a high group or middle group teacher that is associated with a unit change in a given independent variable. An odds ratio greater than 1 indicates a positive association between a dependent variable and an independent variable, while the odds ratio of less than 1 indicates a negative association between them.

It was found that both teacher characteristic factors (i.e., major and professional development participation) and school context factors (i.e., teachers' perceived academic emphasis on higher level thinking and perceived school safety) are associated with teachers' mathematics instruction and self-efficacy typology. In Korea, teachers' educational backgrounds are not significantly associated with teachers who deliver high-quality mathematics instruction with high self-efficacy (high group). However, in the United States, the coefficient of teachers who majored in "education and mathematics" is .88, indicating that teachers who majored in education and mathematics are about 2.4 times more likely to be classified into the

Table 4. Results from multinomial logistic regression that predict teacher instruction and self-efficacy typology

Variable	United States (*n*=537)				South Korea (*n* =375)			
	Middle Group		High Group		Middle Group		High Group	
	β	O. R.	β	O. R.	B	O. R.	B	O. R.
Teacher characteristics								
Major (reference = no Edu, no Math)					Major (reference = no Math)			
Edu, No Math	.39	1.48	.86†	2.36	.		.	
Math, No Edu	-.24	.79	.26	1.30	.23	1.26	.32	1.38
Edu, and Math	.01	1.01	.88*	2.41				
Gender (reference =female)	.31	1.36	-.01	.99	-.34	.71	.19	1.21
Professional development	.56***	1.75	.36**	1.43	-.15	.86	-.24	.79
Teacher year	-.02	.98	-.02	.98	.01	1.01	.01	1.01
School contexts								
Working conditions	.18	1.20	.30	1.35	.01	1.01	-.20	.82
Perceived academic emphasis	.45	1.57	.78*	2.18	.54*	1.72	1.04**	2.83
Perceived school safety	.05	1.05	.48†	1.62	-.23	.79	.61	1.84
Perceived job satisfaction	.15	1.16	.36	1.43	.31	1.36	.97**	2.64

*†p<.10, *p<.05, **p<.005, ***p<.001.*

β=coefficient; O.R.= odds ratio; Reference group = Low group.

"high group" compared to teachers who did not major in education or mathematics. This finding is consistent with Akiba, LeTendre, and Scribner (2007), who highlighted excellence in the teacher workforce in South Korea. According to Akiba et al., only 4.8% of teachers in South Korea taught mathematics without a major in mathematics or mathematics education; in contrast, in the United States, the percentage was 29.7% of teachers. Adding to the findings from Akiba et al., our study shows that teachers' educational background (i.e., majoring in "education and mathematics") is a determinant of teachers who provide quality instruction with high self-efficacy in the United States, yet this factor is not weighted to Korean mathematics teachers.

Several school contexts are positively associated with teacher mathematics instruction and self-efficacy typology in the data of the United States, which include perceived academic emphasis and perceived school safety. The perceived academic emphasis coefficient for the high group of teachers in the United States is 0.78, indicating that a one unit increase in the perceived academic emphasis index (for example, from medium to high emphasis or from high to very high emphasis) is associated with a 2.18 times more likely to be teachers who deliver high-quality mathematics instruction with high self-efficacy. In addition, PD opportunities are found to significantly distinguish teachers in the middle group (that is, a teacher with high-quality instruction but low self-efficacy or low-quality instruction but high self-efficacy) from teachers in the low group. The PD coefficient for middle group teachers is 0.56, indicating that a one unit increase in the participation of PD is associated with a 75% increase in the odds of classifying into the middle group of teachers. The PD coefficient for the high group of teachers is 0.36, suggesting that a one unit increase in the participation of PD is linked to a 36 percent increase in the odds of classifying into the high group of teachers. This finding suggests that teachers in both the high and middle groups in the United States tend to report that they participated in PD opportunities focusing on curriculum and inquiry methods more often than teachers in the low group who provide cognitively low demanding instruction with low self-efficacy.

As reported above, teacher major is not significantly associated with teacher math instruction and self-efficacy typology in the Korean data, which suggests that this factor is not a determinant since most Korean teachers majored in either math or mathematics education. In addition, two school-level factors – teachers' perceived academic emphasis on understanding and job satisfaction – were found to be significantly associated with teacher math instruction and self-efficacy typology in Korea. Similar to U.S. data, perceived academic emphasis is found to be positively associated with teacher math instruction and self-efficacy typology in Korea. The perceived academic emphasis coefficients for middle and high groups are 0.54 and 1.04, respectively. These findings indicate that a one unit increase in the perceived academic emphasis index is related to a 1.7 times more likely to be a teacher who belongs to the "middle group" and 2.8 times to be teacher who belongs to the "high group."

However, the associations between two school contexts (i.e., perceived school safety and perceived job satisfaction) and teacher mathematics instruction and self-efficacy typology differ across the two countries. First, teachers' perceived school safety is positively associated with teachers who deliver high-quality instruction with high self-efficacy in the United States compared to teachers who claim to provide low-quality instruction with low self-efficacy. However, there was no such association between them in South Korea. In addition, while teachers' perceived job satisfaction is not linked to teacher mathematics instruction and self-efficacy typology in the United States, it is significantly related to teachers in the high group compared to teachers in the low group in Korea. In other words, there is a statistically significant difference in teachers' perceived job satisfaction between the high group of teachers and the low group of teachers in South Korea, but this is not the case in the United States.

The perceived job satisfaction coefficient for high groups in Korea is 0.97, indicating that a one unit increase in perceived career satisfaction (i.e., from 'less than satisfied' to 'somewhat satisfied' or from 'somewhat satisfied' to 'satisfied') is associated with a 2.6 times more likely to be teachers who deliver high-quality math instruction with high self-efficacy in Korea. This finding seems to be interesting given that prior research reported correlations between self-efficacy and job satisfaction in both Korea and the United States. For example, Klassen et al. (2009), who investigated the validity of the teachers' self-efficacy scale in five countries including both Korea and the United States, reported that there were significant correlations between self-efficacy and job satisfaction in both countries. This finding suggests that the higher self-efficacy on their teaching that teachers develop, the higher job satisfaction they accordingly express in both countries. Robinson (1998) further connected teachers' job satisfaction to their instructional practices by reporting that increased teacher job satisfaction would motivate teachers to continue to improve their instructional practices, generating improved learning environments and increased student achievement. However, different from these findings and assumptions, our study shows that when teachers' self-efficacy is combined with their instructional quality (or instructional emphasis), this is not the case in the United States but it is in South Korea. In other words, no statistically significant difference exists in teachers' perceived job satisfaction between teachers with high-quality instruction and high self-efficacy and those with low-quality instruction and low self-efficacy in the United States. Why does this difference exist between the two countries?

To interpret these different associations between teachers' perceived job satisfaction and teachers' self-efficacy and instruction typology, we further explored how teachers' job satisfaction is correlated with their self-efficacy and instructional quality in both countries. First, as we expected, we found positive correlations between teacher self-efficacy and instruction quality in the United States ($r = 0.23$, $n = 537$, $p < 0.00$) and in Korea ($r = 0.38$, $n = 375$, $p < 0.00$). However, we found different patterns in the association among teacher job satisfaction, teachers' self-efficacy, and instruction quality in the United States and South Korea. For example, whereas there are positive correlations between job satisfaction and instruction quality ($r = 0.26$, $n = 375$, $p < 0.00$) and between job satisfaction and self-efficacy ($r = 0.16$, $n = 375$, $p < 0.00$) in South Korea, there was a positive correlation only between job satisfaction and instruction quality ($r = 0.24$, $n = 537$, $p < 0.00$), but not between job satisfaction and teachers' self-efficacy ($r = 0.08$, $n = 537$, $p > 0.05$) in the United States. The lack of a positive correlation between job satisfaction and teachers' self-efficacy in the United States indicates no statistically significant difference between teachers with high-quality instruction and high self-efficacy and those with low-quality instruction and low self-efficacy in the United States.

This finding made us speculate on the mediated effect of U.S. teachers' perceived school safety on job satisfaction. Thus, we further explored the link between school safety, job satisfaction, and teacher instruction and efficacy typology. We ran a model that did not control for school safety and another model that controlled for school safety and then compared the coefficient of perceived job satisfaction across these models. Our supplementary analyses revealed the mediated effect of U.S. teachers' perceived school safety on job satisfaction. According to Martino (2003), school atmosphere and school safety are positively associated with teacher job satisfaction. The more favorable school safety, including the working conditions, was, the higher the job satisfaction scores were. In our study, teachers' perceived school safety is directly linked to teachers who deliver high-quality instruction with high self-efficacy in the United States compared to teachers who claim to provide low-quality instruction with low self-efficacy. However, teachers' perceived school safety is not related to the quality instruction and high self-efficacy typology in South Korea. This finding suggests teachers' job satisfaction is mediated by school safety in the United States, but not in South Korea. That is, our finding suggests that job satisfaction may indirectly influence teachers' self-efficacy and instruction through school safety in the United States. Highlighting the importance of school safety, this finding and interpretation provides implications for policymakers and school administrators who intend to improve teachers' self-efficacy and quality instruction, in particular in the U.S. context.

Furthermore, while 'teachers' opportunities to learn in professional development programs' was a significant factor that leads to quality instruction and high self-efficacy in the United States, it was found to be not statistically significant in South Korea. This finding suggests that while teachers in the high group in the United States tended to report that they attended PD emphasizing curriculum, instructional approaches, and problem solving more frequently than those in the low group, this is not the case in the Korean context. This finding can be explained by differences in policies and systems of teacher education and development process between two countries (Kang & Hong, 2008). According to Kang and Hong (2008), to build a high-quality teaching workforce, the Korean system tends to focus on the recruitment of top-performing high school graduates into teacher education institutions and high-quality initial teacher education. In contrast, according to Akiba and LeTendre (2009), the U.S. system tends to focus on in-service and professional development programs rather than entry requirements for teacher education programs. These different policies might lead to different patterns in the association between professional development and teacher typology between two countries. That is, high quality in the teacher workforce at entrance in teacher education may produce a smaller improvement in professional development opportunities.

Factors associated with 8th graders' mathematics achievement

Table 5 displays the factors that are associated with 8th graders' mathematics achievement in Korea and the United States. While student-level factors are commonly associated with students' mathematics achievement across two countries, different patterns exist in the association between teacher-level factors, school-level factors, and student mathematics achievement. First, we found different patterns in the association between teacher math instruction and self-efficacy typology and student math achievement between the two countries. There is a significant positive association between teacher math instruction and self-efficacy typology and student mathematics achievement in the United States, even after controlling for other student, teacher, and school backgrounds. Nonetheless, we found no significant relationship between teacher mathematics instruction and self-efficacy typology and student mathematics achievement in Korea. Specifically, only U.S. students who were taught by high group teachers (teachers with high-quality math instruction and high self-efficacy) have 9.88 higher mathematics achievements scores than students who were taught by teachers with low quality of mathematics instruction and low self-efficacy. Interestingly, no significant difference in mathematics achievement was observed between students who were taught by "high group teachers" and those by "low group teachers" in Korea.

In addition, while teachers' years of teaching experience was commonly associated with 8th graders' mathematics achievement in both countries, teachers' educational background (i.e., major) and their 'perceived academic emphasis' factors were found to be associated with students' mathematics achievement only in the United States. Furthermore, the 'professional development opportunities' factor

Table 5. Factors that are association with student mathematics achievement

Student math achievement	United States		South Korea	
	Coefficient	S.E.	Coefficient	S.E.
Instruction and self-efficacy typology				
Middle group	.52	4.00	-.68	-.14
High group	9.88*	4.61	-.11	-.02
Teacher characteristics				
Teacher major (reference = no Edu, no Math)			Major (reference = no Math)	
Edu, No Math	-4.79	4.71	.	.
Math, No Edu	-1.26†	5.45	-.28	-.06
Edu, and Math	5.31	4.72		
Teacher gender (reference = female)	-.56	3.82	-6.63	-1.18
Years of teaching experience	.31†	.17	.60*	2.54
Professional development opportunity	-1.07	2.13	-.94	-.42
School characteristics				
Perceived academic emphasis	7.98*	3.24	1.74	.42
Working condition	3.38	2.67	-6.84†	-1.76
Perceived school safety	1.78	3.58	5.93	1.21
Perceived job satisfaction	-4.25	3.21	7.12	1.57
Student characteristics				
Home book possession	12.96***	.79	19.50***	18.22
Educational aspiration of students (reference = primary)				
Lower secondary	2.53	8.90	3.49	1.13
Upper secondary	1.52	1.01	-	-
Associate degree	22.11*	9.82	83.28**	3.11
B.A.	38.9***	8.93	124.23***	4.64
M.A. or above	57.17***	9.07	134.00***	5.01
Parent education (reference = primary)				
Lower secondary	2.9	5.16	-2.34	-.14
Upper secondary	14.5**	5.01	17.86	1.34
Associate degree	14.02*	5.54	29.28*	2.04
B.A., or above	26.49***	5.18	46.57***	3.38
Race (reference = White)				
Black	-49.62***	4.17		
Hispanic	-18.13***	3.07		
Asian	36.62***	5.63		
Multiracial	-9.02*	3.75		
Other	-38.98***	6.24		
Gender (reference = female)	7.03***	1.61	6.74*	2.74
Constant	393.66***	14.8	37.06***	11.7
	N = 10,445		N = 5,170	

*†p<.10, *p<.05, **p<.005, ***p<.001.*

was not statistically associated with students' mathematics achievement both in the United States and Korea, which provides suggestions to school administrators in both countries.

At the student-level factors, we found that except for race, all student background factors explored in this study were commonly associated with student mathematics achievement in both countries. First, there were significant gender differences in math achievement in the United States; boys' mathematics achievement is about 7 points higher than girls' mathematics achievement. Second, substantial differences existed across racial groups; Black, Hispanic, and multi-racial students tended to have lower math test scores than white students, whereas Asian students tend to have higher math scores than white students. Third, we found that students from advantaged family backgrounds tended to have higher math scores than students from disadvantaged family backgrounds. For example, students whose parents finished some college education or above tended to have higher math achievement than students whose parents finished only primary education. Fourth and lastly, students' educational expectations were positively associated with students' mathematics achievement; students who expected at least an associate's degree or above tended to have higher mathematics achievement scores than students who expected to finish only primary education.

Similarly, in South Korea, the aforementioned student characteristics and family backgrounds, including parent's education level, the number of books possessed at home, student gender, and students' educational aspiration, were positively associated with their mathematics achievement. These findings suggest that, in Korea, students from advantaged families tend to have higher mathematics achievement scores. In addition, there were male-favorable gender gaps in mathematics achievement in Korea, which were found in previous 1995 and 2003 TIMSS datasets (Neuschmidt, Barth, & Hastedt, 2008). Furthermore, when students expect to complete at least some postsecondary education (that is, an associate's degree or above), they tend to have higher mathematics achievement scores compared to their peers who expect to finish only primary education.

DISCUSSION AND IMPLICATIONS

This study contributes to the current literature on student learning and teacher education. Prior research on factors that affect student achievement considered instructional quality and teacher self-efficacy separately. The current study expands prior research by examining the association of teacher mathematics instruction and self-efficacy typology and revealing the factors that are associated with teachers who deliver quality instruction with high self-efficacy.

Table 6 illustrates the factors that are associated with high-quality teachers and those associated with student achievement in the United States and Korea.

What factors are associated with students' achievement in the United States?

In the U.S. context, teachers' major (that is, education and mathematics), teachers' perceived school safety, their perceived academic emphasis on conceptual

Table 6. Factors association with student math achievement in the United States and Korea

Influential factors with high-quality teachers	**United States**	**Korea**
Teacher major	0	X
Professional development	0	X
Perceived academic emphasis	0	0
Perceived school safety	0	X
Perceived career satisfaction	X	0
Influential factors with student achievement		
Teacher variables		
Instruction and self-efficacy typlogy	0	X
Teacher major	0	X
Teacher gender	X	X
Years of teaching experience	0	0
Professional development	X	X
School characteristics		
Perceived academic emphasis	0	X
Working condition	X	0
Perceived school safety	0	0
Perceived job satisfaction	0	0
Student variables		
Home book possession	0	0
Educational aspiration of students	0	0
Parent education	0	0
Gender	0	0

understanding, and professional development opportunities are collectively associated with teachers who emphasized cognitively demanding instruction with high self-efficacy. In particular, we found a positive association between teacher math instruction and self-efficacy typology and student mathematics achievement in the United States. The finding suggests that not only cognitively demanding instruction but also improvement of teachers' self-efficacy may lead to improvement of students' mathematics achievement in the U.S. context. In addition, given the importance of teachers' perceived academic emphasis on conceptual understanding and professional development, professional developers need to provide learning opportunities for teachers to explore cognitively demanding tasks in connection to their curriculum materials. Furthermore, school administrators may emphasize students' inquiry learning with high expectations.

Consistent with the findings from prior research (e.g., Kupari, 2006; Lokan & Greenwood, 2000), this study showed that student home background characteristics, such as parents' education and the number of books at home, have positive associations with students' mathematics achievement. Students' educational aspiration is also found to be positively associated with their mathematics performance. Moreover, although the gender gaps in mathematics and science have narrowed over time (Neuschmidt, Barth, & Hastedt, 2008), there is a significant difference in mathematics achievement scores in favor of boys overall. Disparities of math achievement on the basis of gender and race in the United States suggests that in order to promote overall students' mathematics achievement, special attention should be given to students depending on their race and gender. This finding calls for teachers to consider how to close the gender gap in mathematics.

What Factors are Associated with 8th Graders' Mathematics Achievement in South Korea?

Different from the findings in the United States, teacher mathematics instruction and self-efficacy typology was not associated with Korean students' mathematics achievement. This is interesting to us given the importance of teacher self-efficacy in teaching. Why did this happen? One possibility would be the popularity of private tutoring. According to Park (2004) and Kang and Hong (2008) who articulated various reasons that may account for the high level of performance of Korean students in international comparative studies of mathematics achievement, there are many private institutions and tutoring courses dedicated to preparing students for mathematics. According to a survey administered by the Korean Institute of Educational Development (KEDI, 2003), 72.6% of the Korean students (83.1% of elementary students, 75.3% of junior high and 56.4% of senior high school students) are receiving at least one private lesson beyond schoolwork. Most secondary school students attend additional private mathematics institutions or receive tutoring outside school hours, thus private institutions and tutoring courses have become major elements of education in Korea in parallel with regular schooling. This tendency may result in the relative insignificance of teachers' instruction and their self-efficacy on Korean students' mathematics achievement. This argument is compelling in that the prevalence of private instruction in South Korea obscures the effect of public education and that of high-quality teachers (Kang & Hong, 2008).

In addition, Korean teachers' relative low self-efficacy, despite their excellence in quality, might be another reason for the lack of significance of teacher mathematics instruction and self-efficacy typology on student mathematics achievement. Although we found positive correlations between teacher self-efficacy and instruction quality in the United States (r = 0.23, n = 537, p < 0.00) and South Korea (r = 0.38, n = 375, p < 0.00), Korean teachers tend to rate their self-efficacy slightly lower than teachers in the United States. Given the importance of teachers' self-efficacy on job satisfaction and cognitively demanding instruction, this finding indicates the importance of finding ways to boost teacher self-efficacy in Korean contexts. Indeed, a similar finding was observed in teachers in other high-achieving East Asian countries such as Hong Kong and Singapore. Dodeen, Abdelfattah, Shumrani, and Hilal (2012) examined the effects of teachers' qualifications, practices, and perceptions on student achievement in TIMSS mathematics between the countries. They reported that while there was a considerable student variance in explaining disparity in student achievement, a small amount of variance was observed between school/class. In particular, Dodeen, et al (2012) reported small teacher effects on student achievement as shown in Korea (Byun & Kim, 2010).

However, similar to teachers in the United States, Korean teachers who claimed to provide cognitively demanding instruction and to possess high self-efficacy tended to work at schools where school administrators put an emphasis on student learning and academic achievement. In addition, these teachers expressed high career satisfaction. Indeed, these findings suggest ways to raise Korean teachers' self-efficacy. That is, school administrators may raise career satisfaction in conjunction with putting a high academic emphasis on student learning. Furthermore, while 'teachers' opportunities to learn in professional development programs' was a significant factor that leads to quality instruction and high self-efficacy in the United States, it was found to be not statistically significant in Korea. Similar to these findings, when we further explored how 'teachers' opportunities to learn in PD programs' is correlated with their self-efficacy and instructional quality in both countries, different associations appeared between the two countries. We found that there were positive correlations between teacher self-efficacy and participation in PD (r = 0.17, n = 537, p < 0.00) and between instruction quality and participation in PD (r = 0.14, n = 537, p < 0.01) in the United States. This means that when teachers report higher self-efficacy and more cognitively demanding instruction, they are likely to report spending more time on PD that emphasizes curriculum, instructional approaches, and problem solving.

In contrast, in South Korea, there was no significant correlation between teacher self-efficacy and participation in PD (r = -0.08, n = 375, p > 0.05). In particular, there was a negative correlation between instruction quality and participation in PD (r = -0.11, n = 375, p < 0.05) in South Korea. These findings suggest that teachers' self-efficacy and teachers' PD opportunities are not related in the Korean context; moreover, according to our analyses of TIMSS 2011 data, when teachers in Korea report that they provide more cognitively demanding instruction, they are likely to report spending less time participating in PD. These findings also suggest that administrators responsible for providing professional development in Korea need to reconsider learning opportunities in PD that are given to teachers. However, because prior studies as well as our study are cross-sectional, it is difficult to assess whether there is a causal relationship between teachers' PD opportunities, their self-efficacy, and their instructional practices in South Korea. Thus, to better understand the link among PD, self-efficacy, and instruction in Korea, future research using longitudinal data is warranted.

Another common finding between the countries is that student home background characteristics, such as parents' education, the number of books at home, and students' educational expectations, were found to be positively associated with students' mathematics achievement in Korea. This finding was consistent with prior research that investigated factors affecting Korean students' achievement using TIMSS 1999, 2003, 2007 data (Park & Park, 2006). Furthermore, although the gender gap is getting smaller in student achievement both in mathematics and science (Neuschmidt, Barth, & Hastedt, 2008), we noticed that Korean female students tended to show lower mathematics achievement than male students, suggesting that policymakers and educational researchers should continue their efforts to reduce the gender gap in mathematics achievement.

Implications

The results from the current study indicate that improvement of self-efficacy as well as instruction is important for student achievement both in the United States and Korea. Results from this study suggest that the quality and training of teachers and students' gender gap in achievement are significant concerns. In particular, this study has implications for policymakers, school administrators in charge of profession developers, teacher educators, and future researchers in finding better ways to improve student mathematics achievement.

First, policymakers and school administrators need to provide a working environment where teachers can highly value their jobs and careers while placing academic emphasis on student learning. This study showed that when school administrators strongly emphasized the importance of student understanding in learning mathematics instead of memorization and procedural knowledge, teachers in both countries tended to report that they deliver mathematics instruction that focuses on student thinking and reasoning with high self-efficacy. Thus, this study highlights the alignment between school administrators' educational visions and recommended teaching practices. In addition, school administrators in both countries need to pay attention to school safety issues, which can influence teachers' job satisfaction and which are related to teachers' self-efficacy and their instructional quality. In our study, teachers' perceived school safety was positively associated with teachers who claim to deliver high-quality instruction with high self-efficacy in the United States. However, we did not find any association of the school safety factors with teachers' instruction and self-efficacy typology in South Korea. This finding suggests that when teachers perceive a safer school environment, they tend to express higher self-efficacy and deliver quality instruction in the United States. Indeed teachers' perceived job satisfaction and school safety are associated with students' mathematics scores in both countries (see Table 5). Interestingly, U.S. teachers' overall perceived school safety rating is higher than that of Korean teachers. The mean scores of teachers' perceived school safety in the United States and Korea were 2.43 and 1.98, respectively, on a 3-point Likert scale ranging from 1 (not safe and orderly) to 3 (safe and orderly) (see Table 1). Policymakers and school administrators in both countries should attend to school safety issues to help teachers provide quality instruction and ultimately improve student mathematics achievement. This effort should be done with teacher educators and those responsible for professional development.

Professional developers in South Korea need to find a better way to promote teacher self-efficacy and teachers' skills and knowledge in delivering cognitively demanding instruction. Overall, the PD opportunity factor was not associated with students' mathematics achievement in either country. Moreover, while participation in PD opportunities was a significant factor that characterizes teachers with high self-efficacy and quality instruction in the United States, this is not the case in South Korea. Furthermore, our study revealed a negative correlation between instruction quality and participation in PD in South Korea. We acknowledge that recently, to enhance the professionalism of teachers, a model for training mathematics teachers has been developed based on their life cycle by the Korean Ministry of Education, and innovative training programs including PD are underway. Although there is no known study that has explored the effect of the new policy on teaching practices, the findings of this study suggest that much effort should be made to develop a more sustainable teacher professional training program, in which teachers can gain confidence in engaging students, managing student behavior, and using effective instructional strategies.

In addition, given male students' higher mathematics achievement in the United States and South Korea, professional developers in both countries should consider how to help teachers differentiate their instruction not only by content but also by gender. Given controversial claims that teachers consistently privilege boys over girls (e.g., with more positive feedback and helpful questions), professional developers need to pay attention to the various ways gender responsiveness training can be offered to teachers. Teacher educators and providers of professional development programs need to help pre-service and in-service teachers understand and respond to the specific needs of girls and boys in the teaching and learning processes. They can do this by being aware of the special needs of girls and boys, such as sexual maturation issues, and by encouraging equal participation and involvement of boys and girls in class activities and by ensuring equal access to learning materials. Providers of professional development programs also should provide opportunities for teachers to develop an awareness of the various ways to respond to the specific needs of girls and boys through teaching and learning processes, which is known as "gender responsive pedagogy" (Sparks, 1994). For instance, providers of professional development programs should ask teachers to take into consideration the girls' and boys' specific needs in content, learning materials, methodologies and activities, and classroom arrangement. When planning a lesson, teachers may be asked to review the teaching and learning materials for gender responsiveness by answering whether the materials contain gender stereotypes. Some teaching methodologies like group work, group discussions, role play, debates, and explorations can be effective in encouraging student participation. Teachers can benefit from being asked to ensure equal participation of both girls and boys.

Lastly, this study has implications for further research with in and outside of Korea. This study focused on U.S. and Korean data, which have their own unique characteristics. Because this study used cross-sectional data, the study is limited in explaining *why* Korea and the United States show different patterns in the factors that are associated with teacher typology. For example, it would be informative to examine why Korean teachers who are satisfied with their jobs tend to deliver high-quality instruction with a higher level of self-efficacy than those who are not satisfied with their job. However, because of the complexity of teaching practices, the findings in this study are not limited to the United States and South Korea and may have more general implications for future researchers in other countries. The current study calls for future research to verify its findings. It would be interesting to see whether the same factors are associated with student mathematics achievement in different countries. In addition, future researchers in Korea could analyze how strongly the variables that were identified in the study predicted mathematics achievement in TIMSS 2007. Despite the importance and influence of private tutoring on student mathematics achievement in South Korea, we could not take this factor into consideration in our analysis because the TIMSS 2011 survey does not include this variable. Given that TIMSS 2003 includes data for private tutoring, it would be interesting to explore whether and how the relationship between teacher quality and student achievement is attributed to private tutoring in Korea. Furthermore, based on the findings of this study, we hypothesized the mediated effect of teachers' perceived school safety on job satisfaction and teachers' self-efficacy and quality instruction typology. Thus, future research that explores the pathways will help explain direct and indirect relationships of various factors that are associated with teachers who provide quality instruction with high self-efficacy. Lastly, this study reported the related teacher factors on student mathematics achievement in terms of teacher beliefs about what they ought to be doing, rather than what they are actually doing. The findings of our study can be a basis for qualitative studies. We will benefit from future research that examines the influence of instructional practices on student achievement using qualitative research methods in both the United States and South Korea.

AUTHORS' NOTE

The first two authors contributed equally to the manuscript.

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APPENDIX

Appendix A. Variables used in the analysis

Variable name	Description
Student characteristics	
Math test scores	Five plausible math assessment scores
Female student gender	A dummy variable coded 1 if a student is female.
Race/Ethnicity	Set of 6 dummy variables, indicating whether a student's race is White (reference group), Black, Hispanic, Asian, Multiracial, or other race.
Educational expectation	Set of 7 dummy variables, indicating whether a student expect to complete (1) primary education (reference group), (2) lower secondary education, (3) upper secondary education, (4) an associate degree, (5) a BA degree (6) a master degree or above, and (7) I don't know.
Parents' highest education level	Set of 5 dummy variables, indicating whether a parent finished (1) primary education (reference), (2) lower secondary, (3) upper secondary, (4) post-secondary but not university, and (5) university or above.
Home book possession	Ordinal variables indicating the number of books at home.
Teacher characteristics	
Female teacher	A dummy variable coded 1 if a teacher is female.
Teaching experience year	Number of years of experience the teacher has in any school.
Teachers' major	USA: Set of 4 dummy variables, indicating whether a math teacher is (1) no major in education and math [reference group], (2) major in education but math, (3) major in math but education, and (4) major in both education and math. South Korea: A dummy variable coded 1 if a math teacher's major includes mathematics.
Professional development participation	Numerical variable; the factor score of the three different types of participation in professional development on contents, curriculum, and pedagogy
School contexts	
Perceived collaboration index score	Numerical variable which ranges from 1 to 3; sometimes collaborative, collaborative, very collaborative
Perceived working condition index score	Numerical variable which ranges from 1 to 3; moderate problems, minor problems, hardly any problems
Perceived academic emphasis in school index score	Numerical variable which ranges from 1 to 3; medium emphasis, high emphasis, very high emphasis
Perceived career satisfaction index score	Numerical variable which ranges from 1 to 3; less than satisfied, somewhat satisfied, satisfied
Perceived safe and order in school index score	Numerical variable which ranges from 1 to 3; not safe and orderly, somewhat safe and orderly, safe and orderly

Appendix B. Parameter estimates of the factor analysis of teacher instruction, and professional development participation

Country		Item	Component	Eigen value	% of Variance	α
South Korea	Instruction	Explain their answers	.791	2.669	67.214	.837
		Relate what they are learning in mathematics to their daily lives	.822			
		Decide on their own procedure for solving complex problems	.867			
		Work on problems for which there is no immediately obvious method of solution	.797			
	PD participation	PD for match content	.836	2.155	71.835	.810
		PD for match pedagogy	.871			
		PD for match curriculum	.836			
United States	Instruction	Explain their answers	.631	2.146	53.662	.711
		Relate what they are learning in mathematics to their daily lives	.709			
		Decide on their own procedure for solving complex problems	.819			
		Work on problems for which there is no immediately obvious method of solution	.758			
	PD participation	PD for match content	.791	1.851	61.697	.689
		PD for match pedagogy	.799			
		PD for match curriculum	.766			