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Universal Beliefs and Specific Practices: Students' Math Self-Efficacy and Related Factors in the United States and China

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Abstract

This study intends to compare and contrast student and school factors that are associated with students' mathematics self-efficacy in the United States and China. Using hierarchical linear regressions to analyze the Programme for International Student Assessment (PISA) 2012 data, this study compares math self-efficacy, achievement, and variables such as math teacher support and socioeconomic status (SES) between 15-year-old students in the U.S. and in Shanghai, China. The findings suggest that on average, students from Shanghai showed higher math self-efficacy and better achievement than those of American students. However, at the student level, similar positive relationships between math teacher support and math self-efficacy and between SES and math self-efficacy were found in both locations. That is, in the U.S. and Shanghai, an increase in math teacher support predicts an increase in math self-efficacy, also higher SES is significantly associated with higher math self-efficacy. In addition, at the school level, the smaller difference in American students' math self-efficacy between higher SES school and lower SES school indicates that the U.S. is more equitable between schools than Shanghai, China in terms of students' math self-efficacy. Implications from this study indicate that improving teacher support in math class and narrowing the gap in students' self-efficacy related to school-level SES is a significant issue for the U.S. and Shanghai, China respectively.

Keywords: self-efficacy, teacher support, math achievement, PISA, SES, the U.S., China, Shanghai

1. Introduction

The Program for International Student Assessment (PISA) 2012 report suggests that mathematics achievement of students in Shanghai, China is the highest among all Organization of Economic Cooperation and Development (OECD) countries, with a score of 613, and that the United States is significantly lower than the OECD average of 500, with a score of 481 (OECD, 2014a). Many scholars and educators became extremely eager to understand the gap in order to improve students' achievement in the U.S. American researchers and educators have been working on this low achievement issue for years (Lee, 2009). The "common core state standards" (CCSS) initiative has been launched in 2009 and implement in 42 states as of 2015 which aims to have the states adopt uniformly high standards for K-12 students in Mathematics and English Language Arts (Common Core Standards, 2013; Gerwertz, 2012; Porter, McMaken, Hwang, & Yang, 2011). The CCSS are similar to the centralized and uniform curriculum standards of China. Why then is there a disparity in math achievement between American and Chinese students? From the perspective of educational psychology, a possible answer lies in math self-efficacy. Some researchers have explored the potential effect of math self-efficacy on mathematics achievement to explain in part why some students perform better than other students.

Self-efficacy, according to Bandura's definition, refers to "people's judgments of their capabilities to organize and execute courses of action required in attaining designated types of performances" (Bandura, 1986). In a school context, self-efficacy strongly influences the students' academic performance (Yıldırım, 2012; Kitsantas et al., 2010; Pajares & Miller, 1994). To be specific, the findings from a variety of studies have shown that self-efficacy of math was positively related to a students' math academic performance. It is the most important self-construct in predicting math performance and a main part of achievement-related motivational beliefs (Kitsantas et al., 2010; Lee, 2009; Liu & Zhou, 2007; Yıldırım, 2012; Zajacova, Lynch, & Espenshade, 2005; Zhang, 2007). Additionally, students' family socioeconomic status (SES) can positively influence their self-efficacy and performance (Kisantas et al., 2010; Wigfield et al., 2006; Eccles, Wigfield, & Schiefele, 1998).

The ultimate impact of CCSS depends on the translation of state standards into local practices and the capacity of schools and teachers to help students be more prepared and meet the higher standards (Brown & Clift, 2010; Lee, Liu, Amo, & Wang, 2014). Some teacher-related factors and school-level factors might influence students' self-efficacy and performance. Previous studies have reported that perceived teacher support is a significant factor affecting self-efficacy and academic achievement (Yildirim, 2012; Lapointe et al., 2005; Pianta, 1999; Wentzel, 1998; Garmezy, 1994). School level SES difference has also been reported to be a strong predictor of math self-efficacy in a positive way (Yildirim, 2012).

Nevertheless, comparative studies involving samples from the U.S. and high achieving East Asian countries are insufficient. Specifically, few scholars have examined the similarities and differences in math self-efficacy and related factors between the United States and China. Facing the large gap in math achievement between the United States and China as presented in PISA 2012, it is necessary to look into the educational systems and socio-cultural factors in both countries to determine the variables which are associated with student math achievement, so that the educational practitioners could work to improve the specific issues in the respective countries.

Therefore, the goal of this study is to investigate and compare the American and Chinese students' math self-efficacy and certain factors that may be associated with it in order to refine the understanding of the achievement gap.

2. Literature Review

2.1 Theoretical Framework

The Eccles Expectancy-Value Model of achievement motivation suggests that achievement related choices and performances are assumed to be influenced by student motivational beliefs. In this model, student beliefs about how well they would perform on tasks, either now or in the future, are specified as efficacy expectations and analogous to self-efficacy beliefs defined by Bandura (1997) (Bandura, 1997; Eccles & Wigfield, 1995; Wigfield et al., 2006). In the academic domain, self-efficacy refers to the belief students hold about their capability to successfully perform and complete academic tasks (Bandura, 1997). The four primary sources of self-efficacy are: 1) mastery experiences: interpretation of one's own performance; 2) vicarious experiences: observation of others' performances; 3) social persuasions: messages received from others including teachers, parents and friends; and 4) physiological states: emotional and somatic states, for example, anxiety and stress (Bandura, 1997). Student motivational beliefs or self-efficacy beliefs are influenced by students' perceptions of teacher behaviors and attitudes toward them (Eccles & Wigfield, 1995; Wigfield et al., 2006).

2.2 Math Self-Efficacy of Students in the United States and China

As explained above, Bandura claims that the primary sources of self-efficacy are mastery experiences, vicarious experiences, social persuasion, and physiological responses (Bandura, 1997). All of these sources interact to either develop or impede a person's sense of self-efficacy (Bandura, 1986, 1997). Specifically, for students' math self-efficacy, mastery experiences refer to the interpretation of one's own success in mathematics; vicarious experiences refer to how a student observes the other students' performance in math; social persuasion refers to how encouraging/discouraging the social environment is and feedback from others including teachers, especially math teachers, and parents; and physiological responses are the bodily reactions to a given mathematical task, including anxiety and stress (Bandura, 1993).

In a school context, self-efficacy strongly influences the choices students make, the effort they expend, and how long they persevere in the face of the challenges, all of which will influence their academic performance in general (Pajares & Miller, 1994). A large body of literature indicates that students' math self-efficacy was positively associated with their math achievement (Kitsantas et al., 2010; Pajares & Miller, 1994; Skaalvik, Federici, & Klassen, 2015; Yıldırım, 2012). In addition, students' math achievement impacts their math self-efficacy. That is, math achievement and math self-efficacy may be mutually reinforcing in a positive way (Bandura, 1993; Pajares & Miller, 1994).

In PISA 2003 and some other large-scale international databases including the Trends in International Mathematics and Science Study (TIMSS), students in the United States showed higher math self-efficacy than East Asian students, but their math achievement was lower than the OECD average (OECD, 2004; Lee, 2009). The math self-efficacy level of the United States sample was one of the highest among 45 countries (Lee, 2009). American students demonstrated much higher self-efficacy scores than their Asian peers in the study by Scholz et al. (2002). The tendency of below average math achievement and above average self-efficacy in the United States stayed consistent in PISA 2012 (OECD, 2014a).

Based on the results of studies using large scale international databases, students in East Asian countries, especially Japan and Korea, demonstrated relatively lower math self-efficacy (compared to OECD average) in spite of their high scores on math performance (Lee, 2009; Scholz et al., 2002). Lee's (2009) findings using PISA 2003 revealed a global view of Asian countries; the students in South Korea and Japan exhibited the lowest math self-efficacy among all 41 countries. By analyzing TIMSS data, Scholz et al. (2002) found studens in East Asian countries showed lower levels of self-efficacy when compared to more than 20 other countries. Japan, and Korea in particular, were the lowest. In terms of math achievement, students in these two countries were much higher than the OECD average level in PISA 2003 and PISA 2012 (the focus of which was mathematics) (OECD, 2004; OECD, 2014a).

However, the trend of lower self-efficacy in other East Asian countries and economies might not extend to China. The PISA report suggests the math self-efficacy of students in Shanghai, China to be above the OECD average. Meanwhile, their achievement is the highest among all OECD countries (OECD, 2014a). Why do students from Shanghai, China indicate such a difference in math self-efficacy? The explanation may lie in the specific educational system and other demographic factors. Few scholars have performed a comparison between the United States and China in terms of math self-efficacy. This is partly due to the unavailability of Chinese data in this field before PISA 2012 data was released.

2.3 Teacher Support and Math Self-Efficacy

There are many dimensions that address the definition of teacher support in different ways according to previous research. Klem and Cornell (2004) has defined teacher support in terms of students' perspectives. First, students need to feel that teachers are involved with them in school; that adults in school know and care about them. Second, students need to have the feeling that they can make important decisions for themselves, and the work they are assigned has relevance to their present or future lives. Finally, students also need a clear sense of structure to make decisions. In addition, from the teacher's perception, the definition of teacher support is "the degree to which teachers listen to, encourage, and respect students" (Brewster & Bowen, 2004), which relates to academic achievement. According to research addressing teacher-student relationship, teacher support is identified as, teachers are getting along well with their students. Teachers enjoy spending time with students, and students like to talk to their teachers (Hughes, Cavell, & Willson, 2001). In the current study, Klem & Cornell's (2004) definition is adopted because the items addressing teacher support in PISA 2012 are from the dimension of student perceived teacher support, including students' responses to various behaviors of their math teachers, such as showing interests in their learning, giving them an opportunity to express their ideas, etc. (OECD, 2014b).

Previous studies have frequently reported that student perceived teacher support is one of the factors affecting motivational beliefs (Federici & Skaalvik, 2014; Skaalvik, Federici, & Klassen, 2015; Sakiz, Pape, & Hoy, 2012; Garmezy, 1994; Pianta, 1999) and academic achievement (Federici & Skaalvik, 2014; Klem & Cornell, 2004; Pianta, 1999; Skaalvik et al., 2015). Supportive teacher-student relations in the classroom environment have been shown to influence students' self-efficacy positively (Eccles, 2007; Federici & Skaalvik, 2014; Skaalvik et al., 2015; Wentzel, 1998). Teacher behavior plays an important role in motivational constructs; that is, when students perceive their teacher as supportive, they are more likely to be interested and successful in the class (Federici & Skaalvik, 2014; Lapointe et al., 2005; Wentzel, 1998). The student's perception of teacher proximity and influence is significantly associated with the student's self-efficacy for "average" and "talented" students (Lapointe et al., 2005). Using PISA 2003, Yıldırım (2012) found perceived teacher support was found to be a significant positive predictor of math self-efficacy in Turkey. However, to date, there have been few studies conducted about the relationship between teacher support and self-efficacy in the United States and China from a comparative perspective.

2.4 Socioeconomic Status (SES) and Math Self-Efficacy

A student with a higher SES is more likely to have a higher score on math self-efficacy (Kisantas et al., 2010). Eccles and her colleagues argued that students' family SES (student-level SES) can influence their achievement-related motivation, of which the main components are self-efficacy, task choice, and performance (Eccles, 2007; Eccles, Wigfield, & Schiefele, 1998). Student-level SES was positively related to motivational beliefs in Koutsoulis and Campbell's (2001) study. In addition, Akyol, Sungur, and Tekkaya (2010) demonstrated that some SES variables, such as parents' highest educational level or number of books at home, may be positively related to students using more advanced learning strategies and achievement. The PISA data adopted three criteria to measure student's family SES: the highest level of parental education according to the ISCED classification, the highest parental occupation, and home possessions (e.g., the number of books at home).

School-level SES (the average family SES of all students in one school) difference was found to be a strong predictor of math self-efficacy in Turkey (Yıldırım, 2012). Overall, few scholars have compared the influence of SES on the math self-efficacy, both at the student level and school level, of Chinese students and American students.

2.5 Research Questions

Accordingly, few studies focused on the universals and specifics of math self-efficacy and potentially related factors in the United States and China, particularly addressed these issue both at the student level and the school level. Therefore, the present study intends to explore this issue from a comparative perspective. Specifically, this study addresses the following research questions:

1) Student level

Are math teacher support and student SES associated with math self-efficacy of American and Chinese students?

2) School level

a. Are the relationships between math teacher support, student SES and math self-efficacy different in the U.S. and China?

b. Is there any difference in the relationship between school mean SES and math self-efficacy in the two countries?

3. Methodology

3.1 Data and Sample

In this study, the Programme for International Student Assessment (PISA) 2012 database was selected to examine the research questions. PISA is a worldwide study by the OECD in member and non-member nations and economies of 15-year-old school students' academic performance on mathematics, science, and reading. It was first administered in 2000 and then repeated every three years. It serves the purpose of improving education policies and outcomes. It measures problem solving and cognition in daily life (OECD, 2014a). Mathematics was the major cognitive subject in 2012. PISA 2012 data is the most recent international large-scale dataset focusing on mathematics and including a Chinese sample for the first time.

The student questionnaire data and school questionnaire data in the United States and Shanghai, China were analyzed as an entire sample at the student level and the school level for current study. After list-wise deletion, the final sample is 3,298 students nested in 314 schools. The cases with missing value in any variable were excluded in the final sample, since the missing pattern of PISA data was completely random (OECD, 2013). For the demographic characteristics, see Appendix A.

3.2 Variables

3.2.1 Dependent Variable

Math self-efficacy (MATHEFF). The Original PISA 2012 Index of Mathematics Self-Efficacy (MATHEFF) is derived from students' responses to the eight items in an item stem measuring the students' confidence with mathematical tasks (OECD, 2014b). The item stem of "How confident do you feel about having to do the following mathematics tasks?" is followed by eight specific types of math activities, e.g., calculating the number of square feet of tile needed to cover a floor, calculating how much cheaper a TV would be after a 30% discount, etc. A 4-point Likert-type response of very confident, confident, not very confident, and not at all confident was given to the respondents (Lee, 2009; OECD, 2014b). Missing values for these items are imputed and then transformed to an international metric with OECD averages of 0 and OECD standard deviations of 1 (OECD, 2014b). Because only data for American and Chinese students are analyzed in the current study, the mean might not be 0 and the standard deviation might not be 1 in this study. The greater value on this index represents higher math self-efficacy. The technical report of PISA verifies that the index is a reliable estimate of student's math self-efficacy (OECD, 2014b).

3.2.2 Independent Variables.

Level 1: Student level.

Mathematics teacher support (MTSUP). The original PISA 2012 Index of Mathematics Teacher Support (MTSUP) in mathematics lessons is derived from students' responses to the four items following the item stem of "Thinking about the mathematics teacher who taught your last mathematics class: to what extent do you agree with the following statements?" The items are, for instance, a. My teacher lets us know we need to work hard; and d. My teacher gives students the opportunity to express opinions. A four-point Likert scale with the response categories recoded as "Strongly disagree" (=0), "Disagree" (=1), "Agree" (=2) and "Strongly agree" (=3) was used. All items are inverted and positive values on this index indicate students' perceptions of higher levels of teacher support (OECD, 2013; Yıldırım, 2012). According to the PISA technical report, the index is a reliable estimate of math teacher support (OECD, 2014b).

SES (ESCS). The PISA 2012 database includes a broader socio-economic measure called the Index of Economic, Social and Cultural Status (ESCS), which is derived from three variables related to family background: the index of highest level of parental education according to the ISCED classification (PARED), the index of highest parental occupation status (HISEI), and the index of home possessions (HOMEPOS). A higher ESCS represents a higher SES. Similar to MATHEFF, the OECD average on both indices of MTSUP and ESCS is 0 and the OECD standard deviations is 1 (OECD, 2014b).

Level 2: School level.

Location (LOCATION). The original variable CNT (country code) was recoded as 1 = China, 0 = the United States. In order to conduct a comparison between the United States and Shanghai, China, this variable was set up as a moderator in the present study. CNT moderated the relationship between school mean SES (level 2) and students' math self-efficacy (level 1); the relationship between perceived teacher support (level 1) and students' math self-efficacy (level 1); and the relationship between student SES (level 1) and students' math self-efficacy (level 1).

School mean SES. The student level ESCS was aggregated to school level to get the school mean SES.

3.2.3 Control Variables.

In the current study, gender (FEMALE), grade (GRADE 10), program orientation (GENERAL), immigrant status (NATIVE) and student math achievement (MATHACHI) were statistically controlled on the student level (Kim & Law, 2012). School sector (PUBLIC) was controlled on the school level. See Appendix B for the full descriptions of the variables.

3.3 Statistical Analysis Methods

In this study, all data were analyzed using HLM 7.0 after being weighted by final student weight (W_FSTUWT). An alpha level of .05 was used to denote statistical significance. The cases with missing value in IVs or DV were excluded from the final data using listwise deletion, since the missing pattern of PISA data was random (OECD, 2013).

Hierarchical linear regression analysis was used to explore the relationship between SES and teacher support and math self-efficacy on both the student level (level 1) and the school level (level 2) by country. Three hierarchical linear models were designed to address the research questions.

Model 1. Fully Unconditional Model (One-way ANOVA random effect model without predictors)

Level-1 Model

$$MATHEFF_{ij} = \beta_{0j} + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

MATHEFF is student math self-efficacy: the dependent variable.

Model 2. Partially Conditional Model (Random coefficient model with level 1 predictors only)

Level-1 Model

$$MATHEFF_{ij} = \beta_{0j} + \beta_{1j}*(ESCS_{ij}) + \beta_{2j}*(MTSUP_{ij}) + \beta_{3j}*(FEMALE_{ij}) + \beta_{4j}*(GRADE10_{ij}) + \beta_{5j}*(NATIVE_{ij}) + \beta_{6j}*(MATHACHI_{ij}) + \beta_{7j}*(GENERAL_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + u_{1j}$$
$$\beta_{2j} = \gamma_{20} + u_{2j}$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$
$$\beta_{5j} = \gamma_{50}$$
$$\beta_{6j} = \gamma_{60}$$
$$\beta_{7j} = \gamma_{70}$$

ESCS is the student SES.

MTSUP is the perceived math teacher support.

In this model, all independent variables were centered by group mean. Among these variables, gender (FEMALE), grade (GRADE10), program orientation (GENERAL) immigrant status (NATIVE) and student math achievement (MATHACHI) were control variables on level 1; after testing the partially conditional model with random effect of these variables, there were no between-school differences on the slopes of the control variables, so those random effects were treated as fixed on level 2.

Model 3. Fully Conditional Model (Intercepts and slopes as outcomes model with both level 1 and level 2 predictors)

Level-1 Model

$$MATHEFF_{ij} = \beta_{0j} + \beta_{1j}*(ESCS_{ij}) + \beta_{2j}*(MTSUP_{ij}) + \beta_{3j}*(FEMALE_{ij}) + \beta_{4j}*(GRADE10_{ij}) + \beta_{5j}*(NATIVE_{ij}) + \beta_{6j}*(MATHACHI_{ij}) + \beta_{7j}*(GENERAL_{ij}) + r_{ij}$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(PUBLIC_j) + \gamma_{02}*(ESCS\_MEA_j) + \gamma_{03}*(LOCATION_j) + \gamma_{04}*(INTERACT_j) + u_{0j}$$
$$\beta_{1j} = \gamma_{10} + \gamma_{11}*(PUBLIC_j) + \gamma_{12}*(ESCS\_MEA_j) + \gamma_{13}*(LOCATION_j) + u_{1j}$$
$$\beta_{2j} = \gamma_{20} + \gamma_{21}*(PUBLIC_j) + \gamma_{22}*(ESCS\_MEA_j) + \gamma_{23}*(LOCATION_j) + u_{2j}$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$
$$\beta_{5j} = \gamma_{50}$$
$$\beta_{6j} = \gamma_{60}$$
$$\beta_{7j} = \gamma_{70}$$

ESCS_MEA is the school mean SES.

INTERACT is the variable I created for the interaction between location and school mean SES on math self-efficacy.

In this model, level-1 variables were centered and treated as Model 2. On level 2, PUBLIC (school sector) and ESCS-MEAN (school mean SES) were grand mean centered. Since the adjusted means with control for level-2 control, variables were used here.

For control variables, there were no between-school differences in their slopes, so those random effects were treated as fixed on level 2 in the fully conditional model as well.

4. Results

4.1 Background Results

The descriptive statistics is presented in Table 1 for the entire sample and by location. Specifically, the mean math self-efficacy of the United States sample was lower (mean = .17) than that of Shanghai, China (mean = .91). The mean math teacher support of American students was lower (mean = .30) than that of Chinese students (mean = .53). The mean ESCS was higher in the United States sample (mean = .17) than in the Shanghai, China sample (mean = -.38). The math achievement in the United States sample was below the OECD average (mean = 486), and in China was above the OECD average (mean = 613).

Table 1. Descriptive statistics

Level 1 Variables	Mean	S.D.	United States		China	
			Mean	S.D.	Mean	S.D.
ESCS (SES)	.16	.97	.17	.97	-.38	.95
Teacher Support	.30	1.02	.30	1.02	.53	.95
Math Achievement	489.32	88.27	486.28	85.86	613.08	96.27
Math Self-efficacy	.19	1.01	.17	1.01	.91	1.11
Level 2	Mean	S.D.	United States		China	
			Mean	S.D.	Mean	S.D.
ESCS-MEAN (School mean SES)	-.10	.63	.18	.56	-.38	.58

Based on the background results, HLM was applied to examine the relationships between math teacher support, student SES, school mean SES and math self-efficacy and whether the relationships differ by location.

4.2 Results of Model 1

There was no predictor added in this model. The results (see Table 2) show that the overall mean math self-efficacy of these students was .19 (γ_{00} = .19, t = 5.26, p < .05). The total variance within schools was r = .960, the total variance between schools was u_0 =.074, and the variance between schools was significant (χ^2 = 645.45, p < .05). The intraclass correlation (ICC) was .074/(.074+.960) = .072. This indicated that 7.2% of the variance in math self-efficacy was between schools, which were a significant between-school variance. Therefore, it was appropriate to perform a multilevel analysis (Raudenbush & Bryk, 2002). The relationships between math self-efficacy and related variables at both the student level and the school level were examined in the following analysis.

Table 2. Final estimation of variance components for fully unconditional model

Fixed Effect	Coefficient	SE	t-Ratio	p-Value
INTERCEPT, γ_{00}	.186	.035	5.257	<.001
Random Effect	Variance Coefficient	df	χ^2	p-Value
INTECEPT 1, u_0	.074	311	645.45	<.001
Level-1, r	.960			

4.3 Results of Model 2

After entry of the level-1 predictors and control variables, the results (in Table 3) suggest that the overall mean math self-efficacy of these students above and beyond the effects of level-1 variables was .10 (γ_{00} = .10, t = 4.98, p < .05). On average, student SES was significantly related to math self-efficacy within schools in both countries (γ_{10} = .11, t = 3.60, p < .05). One unit increase in SES was associated with an increase in math self-efficacy by .16. On average, perceived math teacher support was significantly associated with student math self-efficacy within schools in both locations (γ_{20} = .17, t = 6.70, p < .05). One unit increase in math teacher support is related to an increase in math self-efficacy of .17. There was a gender gap in the math self-efficacy within schools in both countries on average (γ_{30} = -.22, t = -4.74, p < .05). Female students' math self-efficacy was .22 lower than their male counterparts. On average, math achievement was significantly associated with student math self-efficacy within schools in the U.S and Shanghai, China (γ_{60} = .01, t = 20.90, p < .05). One point increase in math achievement was accountable for .01 increase of math self-efficacy. Based on the estimation of variance component, the percent of variance explained by level-1 predictors was .96 - .60/.96 = .38.

Table 3. Final estimation of variance components for partially conditional model

Fixed Effect	Coefficient	SE	t-Ratio	p-Value
INCERCEPT 2, γ_{00}	.098	.036	4.979	<.001
For ESCS Slope, γ_{10}	.112	.031	3.603	<.001
For MTSUP, γ_{20}	.167	.025	6.695	<.001
For FEMALE slope, γ_{30}	-.215	.045	-4.739	<.001
For GRADE10 slope, γ_{40}	-.080	.053	-1.505	.132
For NATIVE slope, γ_{50}	-.135	.067	-2.013	.044
For MATHACHIslope, γ_{60}	.006	.000	20.904	<.001
For GENERAL slope, γ_{70}	.280	.614	.457	.648
	Variance			
Random Effect	Coefficient	df	χ^2	p-Value
INTRCPT1, u_0	.116	305	892.23	<.001
ESCS slope, u_1	.019	305	376.84	.003
MTSUP slope, u_2	.018	305	411.70	<.001
level-1, r	.602			

4.4 Results of Model 3

The level-2 predictors and control variables were added to the fully conditional model. The results are presented in Table 4. In this model, school mean SES had a significantly positive effect on student math self-efficacy when controlling for school sector (γ_{02} = .36, t = 5.90, p< .05). One unit increase in school means SES was associated with an increase in math self-efficacy of .36. For math self-efficacy, location had a significant positive effect (γ_{03} = 1.09, t = 22.42, p< .05). The effect size of the moderation of location was $\gamma^*(S_x/S_y)$ = 1.09*(.50/1.01) = .54, which indicated a large effect (Raudenbush & Bryk, 2002). Students in Shanghai, China, on average, had significantly higher math self-efficacy than those of the United States by 1.09, controlling for the effects of school mean SES, school sector and location. There was a significant interaction between location and school mean SES on students' math self-efficacy (γ_{04} = .39, t = 5.10, p< .05).

After controlling for school sector, there was a stronger positive relationship between school mean SES and math self-efficacy in schools of Shanghai, China than in the United States. Specifically, the gap in math self-efficacy between the higher mean SES school and lower mean SES school was smaller in the United States. No interaction between student SES and location on math self-efficacy was found after controlling for the student level variables, school sector and school mean SES (γ_{13} = -.02, t = -.33, p>.05). There was no difference in the relation between perceived math teacher support and math self-efficacy between these two locations after controlling for the school sector and school mean SES (γ_{23} = .03, t = .74, p>.05). In other words, the relationship between student SES, math teacher support and math self-efficacy does not vary by location. In addition, the gender gap existing in the math self-efficacy within schools in both countries did not change after controlling for level 2 variables (γ_{30} = -.22, t = -4.75, p< .05). The same can be said about the positive association between student math achievement and student math self-efficacy in the U.S and Shanghai, China, after controlling for level-2 variables (γ_{60} = .01, t = 20.69, p< .05).

Table 4. Final estimation of variance components for fully conditional model

Fixed Effect	Coefficient	SE	t-ratio	p-value
For INTRCPT1, β_0				
INTRCPT2, γ_{00}	.006	.037	1.628	.104
PUBLIC, γ_{01}	.144	.109	1.318	.188
ESCS_MEA, γ_{02}	.364	.062	5.904	<.001
LOCATION, γ_{03}	1.09	.049	22.426	<.001

INTERACTION (Location * School Mean SES), γ_{04}	.340	.076	5.097	<.001
For ESCS slope, β_1				
INTRCPT2, γ_{10}	.104	.035	2.895	.004
PUBLIC, γ_{11}	-.042	.116	-.370	.712
ESCS_MEA, γ_{12}	.037	.057	.647	.518
LOCATION, γ_{13}	.016	.055	.284	.777
For MTSUP slope, β_2				
INTRCPT2, γ_{20}	.152	.030	4.975	<.001
PUBLIC, γ_{21}	.032	.090	.359	.720
ESCS_MEA, γ_{22}	.045	.050	.893	.372
LOCATION, γ_{23}	.034	.046	.074	.460
For FEMALE slope, β_3				
INTRCPT2, γ_{30}	-.216	.045	-4.750	<.001
For GRADE10 slope, β_4				
INTRCPT2, γ_{40}	-.081	.053	-1.509	.131
For NATIVE slope, β_5				
INTRCPT2, γ_{50}	-.131	.068	-1.987	.052
For MATHACHI slope, β_6				
INTRCPT2, γ_{60}	.006	.000	20.692	<.001
For GENERAL slope, β_7				
INTRCPT2, γ_{70}	.281	.615	.457	.648
Random Effect	Variance Coefficient	df	χ^2	p-Value
INTRCPT1, u_0	.065	301	645.95	<.001
ESCS slope, u_1	.019	304	373.73	.003
MTSUP slope, u_2	.017	304	408.72	<.001
level-1, r	.604			

According to random effects estimation, change in τ_{00} was (.117-.065)/.117 = .44. That is, 44% of the variance between schools in mean math self-efficacy was explained by school sector, school mean SES, and location and the interaction between school mean SES and location. However, variation remained after considering level-2 variables ($p < .05$). Change in τ_{11} was (.0193-.0187)/.0193 = .03. Only 3% of the variance in the relationship between student SES and math self-efficacy, across schools, was explained by school sector, school mean SES, location, and the interaction between school mean SES and location. Those factors cannot explain the relationship between student SES and math self-efficacy ($p < .05$). Change in τ_{22} was (.018-.017)/.018 = .06. Six percent of the variance in the relationship between math teacher support and math self-efficacy across schools was explained by level-2 variables. Those factors cannot explain the relationship between math teacher support and math self-efficacy either ($p < .05$).

5. Discussion

5.1 Math Self-efficacy and Math Achievement in the United States and Shanghai, China

The results in the current study suggest that the math self-efficacy in both locations is above the OECD average level (positive value, overall mean = 0), and students in Shanghai have significantly higher math self-efficacy than their American counterparts, corresponding to their higher achievement. This finding is consistent with the pervious study that students math self-efficacy is found to be positively associated with math achievement (Kitsantas et al., 2010; Pajares & Miller, 1994; Skaalvik, Federici, & Klassen, 2015; Yıldırım, 2012).

However, this is the opposite of the relatively lower math self-efficacy in other East Asian countries based on previous studies (Lee, 2009; Scholz et al., 2002). One possible explanation for this could be different understandings of the measure items between the two countries, which were caused by the different difficulty levels of math curricula (Ma, 1999). The tasks were not challenging to solve for 15 years old students in Shanghai, given that the Chinese national math curriculum is much more demanding than the general level in America for the students of same age (Ma, 1999). Chinese students might have treated these items as math problems more than measurement for psychological traits, and most of them could have been very confident in solving the problems. Thus, more evidence of the validity of the Chinese version of math self-efficacy measurement in PISA is needed to explain this difference. Another possible explanation lies in a specific feature of the Chinese sample. Shanghai is the most developed area in China. Compared to the majority of areas in China, the quality of student performance here is much better. The schools can also recruit the best teachers and provide the best facilities due to the stronger economic support by local government or enterprises (The Editorial Board, 2013; Brown, 2013). Therefore, the students' math self-efficacy may rank highest in China, and higher than the national average level of the United States.

5.2 Student-Perceived Math Teacher Support and Student Math Self-Efficacy

Student-perceived math teacher support is positively associated with student math self-efficacy, both in the United States and Shanghai, China, which keeps congruity with the conclusion of prior studies (Yıldırım, 2012; Lapointe et al., 2005; Wentzel, 1998). That is, in both locations, more teacher support in math class predicts higher math self-efficacy of students. In this study, there is no difference in the association between math teacher support and the math self-efficacy of students in the United States and Shanghai, although on average, Chinese students perceived slightly more teacher support than their American peers. This may be related to the specific cultural background. The education of China (House, Hanges, Javidan, Dorfman, & Gupta, 2004), is greatly shaped by Confucian thought. In the classroom setting, Chinese students are educated to keep to the ritual, honour teachers, and highly value teachers' support, while not encouraged challenging the authority of teachers (Biggs, 1998). Therefore, from students' perspectives, math teacher's supportive behaviors may be appreciated more by Chinese students than their American counterparts.

5.3 Student SES and Math Self-Efficacy of Students

In this study, students with higher SES scores are more likely to have higher math self-efficacy in both locations, after controlling for several student level and school level variables; this is consistent with previous research (Koutsoulis & Campbell, 2001; Akyol et al., 2010). This association does not differ between these two economies. The high SES students reported higher math self-efficacy than the students with low SES in the United States and Shanghai, China.

5.4 School Mean SES and Student Math Self-Efficacy

According to the results, there is an interaction between school mean SES and location on student math self-efficacy. The gap in the student math self-efficacy between the higher mean SES school and lower mean SES school is larger in Shanghai, China, than the United States. That is, the United States is more equitable between schools, compared to Shanghai in terms of math self-efficacy. This possibly is due to the elitist system of China, where greater resources and elite instructors are given to favored schools (The Editorial Board, 2013).

5.5 Student SES and Math Achievement

It is worth mentioning that reverse relationships are present in the descriptive statistics between student SES and math achievement between the two locations. The United States sample shows higher average student SES than Shanghai, but lower math achievement. As a developing country, it is not surprising that China has a relatively lower average SES and income level in general, even though Shanghai is the wealthiest part of China. On the other hand, the math achievement of Chinese students in Shanghai is much higher than that of American students. This finding is consistent with the previous studies on East Asian students (Lee, 2009; Scholz et al. 2002; OECD, 2004). A student's achievement is highly valued by East Asian parents, schools, and societies, regardless of the student's family background (Lee, 2009). The higher quality of students in Shanghai and the much more rigorous national math curriculum in China also could account for the achievement gap in some way (Ma, 1999).

6. Conclusion

6.1 Implications

The findings of this study from a comparative perspective may contribute to the reform of educational system in the United States and China. Teachers in the United States might change their teaching style based on the result of the current study and establish an environment focusing on improving student self-efficacy, which will boost the students' math achievement. The positive relationship between self-efficacy and math achievement is consistent in both locations. Thus, in order to improve the students' performance in math, it is important to increase their math self-efficacy, especially in the United States where the students showed lower self-efficacy, compared to their high performing counterparts in China. Given the importance of self-efficacy to students' achievement, it must be taken into consideration when developing pedagogical strategies to help students meet the CCSS. Additionally, this study provides evidence for Shanghai to take action to narrow the gap between schools, and encourages Shanghai to move away from the elite system toward a more egalitarian, neighborhood attendance system.

6.2 Limitations

There are several limitations existing in the present study. Ethnic groups and racial differences need to be taken into consideration for the United States data, as the United States is known for its characteristic of diversity (Kitsantas et al., 2010). However, the United States specific variable of Race/Ethnicity was not accessible since a Restricted-use Data License of NCES, unfortunately, was not granted for this study. In addition, the Chinese sample only includes the data from Shanghai, the most developed area of China. Schools in Shanghai include the best students in China, applying the most demanding curriculum. The rural-urban gap is very wide in China. In fact, students in Shanghai might have the highest SES among all areas, so the representativeness of the sample may affect the generalization of the findings to all Chinese students. Finally, given results of final model, there are still significant random variances left. Additional studies are planned to examine the effects of other potential variables after more areas of China join the PISA as a whole in 2015. For instance, variables on the parent level and more variables about social-cultural differences will be examined in future studies.

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Appendix A

Descriptive Statistics Table of Background Information

Table A. Descriptive statistics of sample (Unweighted)

	All			United States		Shanghai, China	
Variables	Category	N	Frequency (%)	N	Frequency (%)	N	Frequency (%)
All Students		3298	100.0	1599	100.0	1699	100.0
Gender	Female	1632	49.5	774	48.4	858	50.5
	Male	1666	50.5	825	51.6	841	49.5
Grade	10th Grade	2080	63.1	1175	73.5	905	53.3
	Other	1218	36.9	424	26.5	794	46.7
Program orientation	General	2944	89.3	1599	100.0	1345	79.2
	Other	354	10.7			354	20.8
Immigrant status	Native	2943	89.2	1265	79.1	1678	98.8
	Non-native	355	10.8	334	20.9	21	1.2
All Schools		314	9.5	159		155	
School sector	Public	284	8.6	143	89.9	141	91.0
	Private	30	.9	16	10.1	14	9.0

Appendix B

Descriptions of Variables

Table B. Descriptions of measures and variables

Variables	Name	In Model	Description
Dependent Variable	Math self-efficacy	MATHEFF	MATHEFF Index
Independent Variables (Student Level)	Socioeconomic status (SES).	ESCS	ESCS Index
	Math teacher support	MTSUP	MTSUP Index
Independent Variables (School Level)	Location	LOCATION	United States = 0; China = 1
	School mean SES.	ESCS_MEA	Aggregated from the student level ESCS
Control Variables (Student Level)	Gender Grade Program orientation Immigrant status	FEMALE GRADE 10 GENERAL NATIVE	Gender (FEMALE), it is a categorical variable recoding as 0 = Female, 1 = Male in current study. Grade (GRADE 10), grade variable was recoded into a dummy variable, grade 10 = 1, other grades = 0.Program orientation (GENERAL), the program orientation variable ISCEDO in PISA 2012 was recoded as 1 = General program, 0 = Other program (Vocational & Pre-vocational).Immigrant status (NATIVE), the original variable of IMMIG represent the country of birth in PISA 2012 was recoded as 1 = Native students (Native students), 0 = Non-native students(First and second generation students) (Kim & Law, 2012).
	Math achievement	MATHACHI	In present study, since HLM can't handle the repeated weight, the first plausible value denoted as PV1MATH in the PISA 2012 database for the mathematics scale was used as the value of math achievement for each nation. The OECD average math achievement score in PISA 2012 is 500. According to the OECD report, the average math achievement score for Shanghai, China is 613, and that for United States is 481 (OECD, 2014).
Control Variables (School Level)	School sector	PUBLIC	The original variable SC01Q01 (Public or private) was coded as 1 = Public school, 0 = Private school.