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# Interrelationships among Teacher Self-Efficacy, Collective Teacher Efficacy, and Teachers' Pedagogical Content Knowledge

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# INTERRELATIONSHIPS AMONG TEACHER SELF-EFFICACY, COLLECTIVE TEACHER EFFICACY, AND TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE

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# ABSTRACT

INTERRELATIONSHIPS AMONG TEACHER SELF-EFFICACY, COLLECTIVE TEACHER EFFICACY, AND TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE

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A teacher's self and collective efficacies are assumed to be related to his or her teaching and student learning in a specific content area. His or her pedagogical content knowledge in the subject content area is also assumed to shape his or her teaching practice. In addition, the quality of one's teaching is influenced by the context in which teaching is situated. However, the relationships among teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge situated in individualist and collectivist contexts of teaching mathematics have not been empirically examined adequately. Through the lens of social cognitive theory on teacher efficacy, situated learning perspectives, and concept of pedagogical content knowledge this study examined four research questions around the interrelationships between teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge in two different teaching contexts, the US and China, and explored the difference between Chinese and U.S. mathematics teaching contexts.

Using survey data from secondary mathematics teachers in the US and China, this study employed quantitative research methodology with both parametric and nonparametric methods,

including chi-square test, one-way analysis of variance (ANOVA), and correlation to answer the research questions. The results showed that there was a significant difference between Chinese and U.S. mathematics teaching contexts: the former was more collectivist-oriented and the latter was more individualist-oriented. Compared to their Chinese counterparts, U.S. mathematics teachers scored significantly lower and fewer frequencies on observing instructional practice, critiquing, and providing feedback to their colleagues' teaching. Chinese teachers reported a significant higher score in teacher self-efficacy related to specific teaching tasks, while U.S. teachers reported a significant higher score in teacher self-efficacy related to general teaching tasks. Chinese teacher scored significant higher in group-competence and collaboration and collegiality than their U.S. colleagues, while there was no significant difference in cooperation between Chinese and U.S. teachers. The results also revealed that for Chinese teachers, their specific self-efficacy was significantly associated with their group-competence, cooperation, and general self-efficacy was significantly related to group-competence, cooperation, and collaboration and collegiality; while for U.S. teachers, their general self-efficacy was significantly but negatively correlated with collaboration and collegiality. In addition, the results also showed that for Chinese teachers neither teacher self-efficacy nor collective efficacy was significantly related to pedagogical content knowledge; for U.S. teachers, only specific self-efficacy was significantly and positively correlated with pedagogical content knowledge.

This study contributes to the knowledge base for understanding mathematics teaching contexts in China and the US, which were assumed as collectivist and individualist but have not examined empirically. It also deepens the understanding of the relationships among teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge situated within individualist and collectivist teaching contexts. The findings of this study were discussed

in relation to the teaching/teacher cultures in China and the US, characterized by collectivist and individualist cultures, the different emphases of mathematics teacher preparation, and distinct curriculum and assessment systems. Implications were also addressed regarding mathematics teacher education practice, research in teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge, and cross-cultural comparison.

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# CHAPTER 1 INTRODUCTION

## Statement of the Problem

In this study, I explored the relationships among teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge, which was situated in individualist and collectivist teaching contexts. The focus of this study was developed based on conceptual, empirical, and policy considerations of teacher efficacy and pedagogical content knowledge in teaching and teacher education.

An individual's self-efficacy is defined as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performance" (Bandura, 1997, p. 391). Teacher self-efficacy has been found to be a factor that significantly shapes a teacher's teaching practice (Allinder, 1994; Ghaith & Yaghi, 1997), student learning (Ashton, 1984; Ashton & Webb, 1986; Midgley, Feldlaufer, & Eccles, 1989; Tschannen-Moran & Hoy, 2001), and thus, the effectiveness of educational changes because teacher self-efficacy has been linked to teaching practice and student learning (e.g., Allinder, 1994; Gibson & Dembo, 1985; Tschannen-Moran & Hoy, 2001). Consequently, teacher efficacy has become an important component of both teacher education and education reform (Battista, 1994; Goddard, 2002a; Goddard, 2002b; Goddard, Hoy, & Woolfolk Hoy, 2000; Scharmann & Hampton, 1995). For example, in teacher education practices, this notion is well-accepted that the teacher efficacy helps improve instructional practices and furthermore, student performance (Charalambous, Philippou, & Kyriakides, 2008; Palmer, 2006). However, although teacher efficacy has impacts on teaching and learning (Bandura, 1997; Goddard, 2001, 2002b; Goddard, Hoy, & Woolfolk Hoy, 2000), the research in this area demonstrates three kinds of problems as specified below.

First, teacher self-efficacy is still not clearly conceptualized and its influences on teaching and student learning are still under-studied empirically (Goddard, 2001; Tschannen-Moran & Woolfolk Hoy, 2001). Conceptually, teacher self-efficacy is often conceptualized differently as an operational construct (Fives, 2003a, 2003b; Fives & Buehl, 2008). For example, some scholars define it as "the extent to which the teacher believes he or she has the capacity to *affect* student performance" (Berman et al., 1977, p. 137, italic added); while other scholars view it as "teachers' beliefs or conviction that they can *influence how well students learn*, even those who may be difficult or unmotivated" (Guskey & Passaro, 1994, p. 628, italic added). Still others regard it as "the teacher's belief in his or her *capability to organize and execute courses of action* required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran, Hoy, & Woolfork Hoy, 1998, p. 233, italic added). As "a conceptually elusive construct" (Tschannen-Moran & Woolfolk Hoy, 2001, p. 783) of teacher self-efficacy, lack of a consistently used definition of teacher self-efficacy results in varied approaches to its measurements and makes it "difficult to assess it with certainty" (Hebert, Lee, & Williamson, 1998, p. 224) and to compare different and even contradictory results of teacher self-efficacy. For instance, several measurements of teacher self-efficacy assess it on two dimensions of general teaching efficacy and personal teaching efficacy (Gibson & Dembo, 1984; Woolfolk & Woolfolk Hoy, 1990). Some measurements evaluate teacher self-efficacy on three dimensions of student engagement, classroom management, and instructional strategies (Tschannen-Moran et al., 1998).

Empirically, teacher self-efficacy cannot be accurately measured without considering a specific context for teacher self-efficacy (Henson, 2002; Henson, Kogan, & Vacha-Hassr, 2002; Tschannen-Moran & Woolfolk Hoy, 2001; Wheatley, 2005) because it is viewed to be a domain-

specific construct, which is contingent upon the context (Bandura, 1997; Tschannen-Moran & Woolfolk Hoy, 2001). However, the assessment of teacher self-efficacy quite often ignored the context and content base (Labone, 2004). As Henson (2002) pointed out, "historically, and contrary to Bandura's (1997) formulations, teacher efficacy has been measured rather globally" (p. 140), and this statement echoes Bandura's (1997) comment on teacher self-efficacy scales which "in the most part, still cast in a general form rather than being tailored to domains of instructional functioning" (p. 243). In measuring teacher self-efficacy, for example, teacher participants are typically required to match their judgments of general confidence, such as they are required to respond to the item like "*When I really try, I can get through to most difficult students*" (see Berman et al., 1977, p. 137). This item assesses teachers' general efficacy without specifying their teaching context and content area. As a result, such a measurement of teacher self-efficacy often lacks predictive power (Pajares, 1996; Pajares & Miller, 1995; Zimmerman, 1996) and discriminant validity (Coladarci & Fink, 1995) since teacher self-efficacy varies in different situations and content areas (Ross, Cousins, Gadalla, & Hannay, 1999). Therefore, in measuring teacher self-efficacy and its impacts on teaching and learning, it is important to consider the levels, strengths, and degrees of generality of teacher self-efficacy (Pajares, 1997). However, existing measurements of teacher self-efficacy are often limited to such dimensions as general teaching efficacy, personal teaching efficacy (Gibson & Dembo, 1984), or student engagement, classroom management, and instructional strategies (Tschannen-Moran et al., 1998; Woolfolk & Woolfolk Hoy, 1990). In the examination of teacher self-efficacy and subject areas, only few measurements were developed to measure teacher self-efficacy in particular subject areas such as mathematics and science (Dellinger et al., 2008; Enochs, Smith, & Huinker, 2000; Enochs & Riggs, 1990; Riggs & Enochs, 1990; Roberts & Henson, 2000). Therefore, a subject-

based measurement of teacher self-efficacy with the consideration of a specific teaching context is necessary because of the context- and domain-specific nature of teacher self-efficacy.

Hence, it is imperative for researchers and scholars to consider at least two important things as they evaluate teacher self-efficacy. The first thing is that terms related to teacher self-efficacy should consider viewing teacher self-efficacy as "*the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context."* (Tschannen-Moran, Hoy, & Woolfork Hoy, 1998, p. 233). This definition was used in this study, which emphasizes the key elements of teacher self-efficacy of teachers' perceptions or judgments about his or her capacities and confidence that the teacher possesses regarding certain actions required *for a specific teaching task in a specific teaching context*. The second thing is that evaluation of teacher self-efficacy should take the content knowledge for a specific content area and in a teaching context into the consideration.

Second, teacher efficacy is not only individualistic but also collective in nature. However, collective teacher efficacy is even less well conceptualized, studied, and understood because it has not received sufficient attention in the field compared to teacher self-efficacy (Bandura, 1993, 1997; Klassen, Tze, Betts, & Gordon, 2011; Pajares, 1997). Bandura (1997) proposes the notion of collective efficacy as "a group's *shared belief* in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments" (p. 477, italic added). Bandura argues, "it is people acting coordinatively on a shared belief, not a disembodied group mind that is doing the cognizing, aspiring, motivating and regulating" (Bandura, 2000, p. 76). Following this definition, Goddard, Hoy, and Woolfolk Hoy (2000) suggest that teachers also develop collective teacher efficacy, which is "the perceptions of teachers in a school that the

faculty as a whole can organize and execute the courses of action required to have a positive effect on students" (p. 480). This definition suggests that specific school contexts might play an important role in shaping collective teacher efficacy for teaching a specific content and thus, make the collective teacher efficacy distinct from teacher self-efficacy in a specific school context. Similarly, Zaccaro, Blair, Peterson, and Zazanis (1995) view collective efficacy as "a sense of collective competence shared among individuals when allocating, coordinating and integrating their resources in a successful concerted response to specific situational demands" (Zaccaro et al., 1995, p. 309). In this study collective teacher efficacy was defined as "*a sense of collective competence shared among teachers when allocating, coordinating and integrating relevant resources in a successful concerted response to specific teaching tasks in a specific teaching context."* This definition was used because it provides meaningful ideas of the construct of collective teacher efficacy and emphasizes several key elements of collective teacher efficacy: 1) collective teacher efficacy as the shared beliefs among a group of teachers; 2) collective teacher efficacy as the perceptions of competence in collective coordination activities; 3) collective teacher efficacy as collegiality and collaboration; and 4) the situational-, behavioral-, or task-specificity of collective teacher efficacy.

In the field of teacher efficacy research, the two common approaches to measuring collective teacher efficacy and its influences on teaching and learning failed to properly consider the influences of specific content of teaching and the relationship between teacher self-efficacy and collective teacher efficacy in different school contexts, both of which may impact teaching and student learning (R. Goddard & Goddard, 2001; Kurz & Knight, 2004; Skaalvik & Skaalvik, 2007). For example, Goddard, Hoy, and Woolfolk Hoy (2000) developed a Teacher Collective Efficacy Scale to assess two dimensions of collective teacher efficacy: 1) task analysis, which

means “perceptions of the constraints and opportunities inherent in the task at hand” (Goddard, 2002a, p. 100) and teachers’ beliefs about possible support provided by the students’ home and the community; 2) group-teaching competence, which refers to “judgments about the capabilities that a faculty brings to a given teaching situation” (Goddard, 2002a, p. 100), consisting of inferences about the faculty’s teaching methods, skills, training, and expertise. In this approach subject areas were not taken into account. In another study, Tschannen-Moran and Barr (2004) developed a Collective Teacher Belief Scale to examine collective teacher efficacy on two dimensions of instructional strategies and student discipline, but the context of school teaching is still missing although this measurement focuses more on the influences of collective teacher efficacy on student learning.

Since a group operates through behaviors of its individual members in a specific context in a certain way (Bandura, 2000), it remains unknown how teacher self-efficacy and collective teacher efficacy are related to each other. Therefore, it is important to examine how collective teacher efficacy influences an individual teacher’s instructional practice in a particular content area in different school contexts (Wright, Horn, & Sanders, 1997). For example, teachers who taught in the individualist teaching context possibly develop quite different dispositions toward teaching specific content than those working in collectivist teaching contexts (Little, 1990; Paine & Ma, 1993). Teachers working in an individualist teaching context are more likely to believe independent actions, private autonomy, and individualism, while those in the collective teaching context are more likely to see teaching as collective activities and emphasize collaborations among teachers (Paine, 1997; Paine & Ma, 1993; Wang & Paine, 2003).

An individualist teaching context is assumed to include four key characteristics. First, teachers often work individually in an isolated way (Lortie, 1977), rather than in a collaborative

way with other teachers (Little, 1990). Second, teachers working in the individualist teaching context often lack shared beliefs about teaching and commonly used technical terms and concepts about teaching (Wang & Paine, 2003). Third, teachers heavily rely on their own personal and practical experiences developed through their teaching career rather than shared professional knowledge (Carter, 1990; Clandinin & Connellt, 1995; A. Hargreaves, 1984) when they are teaching. Fourth, teachers have fewer opportunities to share, examine, and reflect on each other's teaching practices in a collective way (Feiman-Nemser & Floden, 1986; Little, 1990) and thus, do not hold accountability for each other's teaching (Wang & Paine, 2003).

In contrast, a collectivist teaching context is assumed to have four features. First, teachers often work with colleagues in a collective way (Little, 1993). Second, teachers working in the collectivist teaching context often hold shared beliefs about teaching, and commonly used technical terms and concepts about teaching (Little, 1990; Paine & Ma, 1993; Wang & Paine, 2003). Third, teachers have to be interdependent on each other to learn how to teach with collegiality and collaboration (Ball, 1994; Little, 1990). Fourth, teachers quite often are organized to reflect teaching practices, examine new conceptions of teaching and learning, and actively engage in collegial interaction (Little, 1990, 2003; Paine & Ma, 1993) and thus, they take responsibility for each other's teaching.

Following this line of thinking, it is reasonable to assume that in the individualist context of teaching, teacher self-efficacy may have more influence on a teacher's teaching practice than their collective teacher efficacy. In contrast, in the collectivist context of teaching, a teacher's self-efficacy may have less influence on their teaching practice than their collective teacher efficacy. As Bandura (1997) pointed out, it is significant to examine the influence of the specific contexts on collective teacher efficacy and its relationship with teacher self-efficacy:

> People working independently within a group structure does not function as social isolates totally immune to the influence of those around them…the sources, impediments, and opportunities provided by a given system partly determine how efficacious individuals can be, even though their work may be only loosely coupled. (p. 469)

This current study helps extend our understandings of how collective teacher efficacy relates to teacher self-efficacy in a specific teaching context. It can also contribute to the understandings of how collective teacher efficacy relates to teachers' pedagogical content knowledge in the individualist and collectivist teaching contexts. However, although it has been assumed that teaching context in China is more collective-oriented (Paine, 1997; Paine & Ma, 1993; Wang & Paine, 2003), while it is more individualist-oriented in the US (Little, 1990, 1993; Lortie, 1975), it has not been empirically examined to what extent this assumption holds. Hence, it is imperative for the researchers and scholars to investigate this assumption to support such proclaim, especially in the international and comparative context.

Third, studies suggest that teacher efficacy influences teaching practices in different ways (Ashton, 1984; Tschannen-Moran & Woolfolk Hoy, 2001), such as teachers' professional commitment (Coladarci, 1992; Lee, Zhang, & Yin, 2011; Ware & Kitsantis, 2007), teacher classroom behaviors (Ghaith & Yaghi, 1997; Gibson & Dembo, 1984; Tschannen-Moran, Hoy, & Hoy, 1998), instructional choice (Flowerday & Schraw, 2000), attitudes to new instructional methods (Ghaith & Yaghi, 1997), and instructional practices (Shi, 2014). As one of the most important components of classroom instruction, teacher knowledge, especially pedagogical content knowledge, has been the focus of mathematics teacher education and mathematics education reform due to its significant influence on instructional quality (Kersting, Givvin, Thompson, Santagata, & Stigler, 2012; Hill et al., 2008; Shulman, 1987; Tchoshanov, 2011;

Wilkins, 2008) and student achievement (Hill, Rowan, & Ball, 2005; Kersting et al., 2012). If teacher self- efficacy and collective teacher efficacy influence teachers' teaching practice and student achievement, it is reasonable to assume that these teacher efficacies should have substantial relationships with teachers' pedagogical content knowledge. However, a closer look at these studies reveal that these studies did not directly examine the relationship between teacher efficacy, collective teacher efficacy, and teacher knowledge in a specific subject and a given teaching context. Thus, it is important to explore whether and to what extent these two types of efficacy beliefs relate to one of the most important components of teachers' instructional practices, specifically teachers' pedagogical content knowledge.

Moreover, studies that examined teacher knowledge often measure teacher subject knowledge using some proxy variables (Hill, Rowan, & Ball, 2005), such as the number of college courses taken (Enochs, Scharman, & Riggs, 1995), prior experience and training (Reid, Vasa, Maag, & Wright, 1994; Sciutto, Terjesen, & Frank, 2000), and earned degrees, or results of basic skills tests. These indexes do not directly measure the nature and characteristics of teachers' knowledge for teaching that is rooted in their subject content and understanding of how they teach a mathematical topic and how students learn about that topic in mathematics (Ball, 1990). For example, in mathematics education, "mathematical knowledge for teaching goes beyond that captured in measures of mathematics courses taken or basic mathematical skills" (Hill, Rowan, & Ball, 2005, p. 372). As a result, measuring proxy variables as teacher knowledge may hinder researchers to get the reliable results. Instead, it is imperative to measure what teachers know about the subject they teach and how they teach the subject to specific groups of students.

Therefore, studies that seek to examine the relationship between teacher self-efficacy and collective teacher efficacy, and teacher efficacy and pedagogical content knowledge should be situated in a specific subject and teaching context and afford exploration of how these two constructs of teacher efficacy relate to teachers' pedagogical content knowledge for teaching.

## Research Questions

This study examined the relationship between teacher self-efficacy and collective teacher efficacy and their associations with teachers' pedagogical content knowledge when they are situated in individualist and collectivist teaching contexts by considering all the aforementioned issues above. In particular, it examined the following specific research questions:

1. Does Chinese mathematics teaching context significantly differ from the U.S. mathematics teaching context?
2. Whether and to what extent do teacher self-efficacy and collective teacher efficacy relate to each other in the individualist and collectivist teaching contexts?
3. Whether and to what extent does teacher self-efficacy relate to teachers' pedagogical content knowledge in the individualist and collectivist teaching contexts?
4. Whether and to what extent does collective teacher efficacy relate to teachers' pedagogical content knowledge in the individualist and collectivist teaching contexts?

## Definition

*Teacher self-efficacy* (TSE) in this study refers to "the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (Tschannen-Moran, Hoy, & Woolfolk Hoy, 1998, p. 233).

*Collective teacher efficacy* (CTE). Based on the definition of Zaccaro, Blair, Peterson, and Zazanis (1995), collective teacher efficacy in this study refers to “a sense of collective competence shared among teachers when allocating, coordinating and integrating relevant resources in a successful concerted response to specific teaching tasks in a specific context”. In this study, I included group-competence, teacher cooperation, and teacher collaboration and collegiality into collective teacher efficacy (CTE).

In this study, I used “teacher self-efficacy” referring to individual teachers’ self-efficacy, “collective teacher efficacy” referring to teachers’ collective efficacy, and “teacher efficacy” referring to both teacher self-efficacy and collective teacher efficacy.

*Pedagogical content knowledge* (PCK). Following Shulman (1986), Ball et al., (2008), and Tatto et al.’s (2008) notion of pedagogical content knowledge, pedagogical content knowledge (PCK) in this study refers to teachers’ “understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons” and it is “the particular form of content knowledge that embodies the aspects of content most germane to its teachability” (Shulman, 1986, p. 9).

*Individualist teaching context* and *collectivist teaching context.* As discussed earlier, individualist and collectivist teaching contexts are two teaching contexts, which distinguish from each other in the ways of the nature of how teachers perform their daily teaching tasks and how teachers work with other teachers, as well as how teachers collaborate with each other. Table 1 listed the key features of individualist teaching context and collectivist teaching context.

Table 1 Key Features of Collective and Individualist Teaching Contexts

| Collectivist Teaching Context | Individualist Teaching Context |
|---|---|
| Teachers often work with colleagues in a collective way. | Teachers often work individually in an isolated way. |
| Teachers often hold shared beliefs about teaching and commonly used technical terms and concepts about teaching. | Teachers often lack shared beliefs about teaching and commonly used technical terms and concepts about teaching. |
| Teachers have to rely on each other to learn how to teach with collegiality and collaboration. | Teachers heavily rely on their own personal and practical experiences. |
| Teachers quite often are organized to reflect teaching practices, examine new conceptions of teaching and learning, and actively engage in collegial interaction. | Teachers have few opportunities to share, examine, and reflect on each other' teaching practices in a collaborative way. |

## Organization of the Dissertation

This dissertation included five chapters. As seen in the previous section, Chapter one provided the background and introduction to the study, along with its four research questions and its significance. Chapter two included the theoretical framework that explained the design of the study and a review of the relevant studies about the relationship between teacher self-efficacy, collective teacher efficacy and how these teacher efficacies relate to teachers' instructional practices, specifically pedagogical content knowledge. Chapter three specifically explained the research methodology, including educational contexts of the study, participants, instruments, data sources and data collection, and data analysis for the investigation of the research questions. Chapter four presented the results of the study. Chapter five included the discussion of the findings, implications, and conclusion.

# CHAPTER 2 THEORETICAL FRAMEWORK AND LIERATURE REVIEW

## Theoretical Framework

Three theories guided the inquiry of the relationships among teacher self-efficacy, collective teacher efficacy, and teacher's pedagogical content knowledge in individualist and collectivist teaching contexts. The first theory is Bandura's social cognitive theory (1986, 1997), which is the most important theoretical base of teacher efficacy research. This theory assumes that what people believe about their ability determines the levels of their motivations, affective states, efforts, and action at individual and collective levels (Bandura, 1993, 1997, 2000). The second theory, the situated learning perspectives, assumes that one's dispositions, knowledge, and skills are situated in and grow out of the contexts in which they are used (Resnick, 1987). The third theory involves the concept of teachers' knowledge for teaching proposed by Lee Shulman (1986), pedagogical content knowledge, and further developed by Ball, Thames, and Phelps (2008) as mathematic knowledge for teaching.

### Social Cognitive Theory

Bandura's (1986, 1997) social cognitive theory has served as a theoretical foundation for the studies of teacher self-efficacy. First, the social cognitive theory suggests that one's personal efficacy beliefs represent "the key factor of human agency" (Bandura, 1982, 1997), which help people make choices through the exercise of agency and have diverse effects on "the courses of action people pursue, how much efforts they put forth in given endeavors, how long they will persevere in the face of obstacles and failures, … and the level of accomplishments they realize" (Bandura, 1997, p. 3). Second, the theory also considers that one's "personal agency operates within a broad network of socio-structural influences" (Bandura, 1997, p. 6), which leads to the exercise of collective agency. Bandura's theory of social cognitive theory indicates that human

agency operates in a triadic reciprocal process among three interrelated factors including environmental factors, human behaviors, and personal factors.

Grounded in Bandura's social cognitive theory (1986, 1997), two theoretical assumptions were developed to guide the studies of teacher self-efficacy and collective teacher efficacy. The first model was Tschannen-Moran et al.'s (1998) assumption of "the cyclical nature of teacher efficacy". This model mainly focuses on teachers' self-efficacy, its function, and the sources that influence its development, which suggests: (1) Teacher efficacy is domain-specific in nature. Teachers who feel efficacious for teaching mathematics to certain students in specific settings may not be expected to feel as efficacious as teaching other subject contents to other students in other contexts; (2) Teacher self-efficacy influences how individual teachers set teaching goals, their efforts to achieve the goals, and their persistence when facing challenges and difficulties in a specific subject content; and (3) The major sources that influence teachers' efficacy beliefs include verbal persuasion, vicarious experience, physiological arousal, and mastery experience. The first two ideas were incorporated into the conceptual model that I developed to guide the examination on the relationship between teacher different kinds of teacher efficacy, the context that shapes their efficacies, and their associations with teachers' pedagogical content knowledge.

The second assumption is Goddard et al.'s conception of the formation, influence, and change of perceived collective efficacy in schools (2004). Goddard et al. (2004) argued that collective teacher efficacy may lead to varied consequences based on their collective analysis of teaching task and assessment of their collective teaching competence. In particular, it emphasizes the reciprocal linkage between collective teacher efficacy and teacher sense of self-efficacy and the impacts of teacher self-efficacy and collective teacher efficacy on the cultural norm in a school, such as teachers' collective effort, persistence, and resilience. This perspective was

incorporated into the conceptual model that I developed to guide the examination of the relationship between teacher self-efficacy and collective teacher efficacy.

### Situated Learning Perspectives

Built on disciplines of anthropology, sociology, and psychology (Greeno, 2003), situated learning perspectives view the learning process as one's participation in socially organized activity, in which learning occurs in a community of practice and that the nature and characteristics of the community shapes both process and outcome of his or her learning (Lave, 1988; Lave & Wenger, 1991). Situated learning perspectives suggest that learning should be a social process whereby knowledge is co-constructed in the social context. Following the theory, learning to teach is viewed to be a process in which a teacher's knowledge is constructed and reconstructed through individual and collaborative inquiry into his or her teaching (Feiman-Nemser & Remillard, 1996; Hiebert & Morris, 2012). This learning process may be situated in a micro-school teaching context and embedded within a particular macro-social and cultural environment.

Little (2003) argued that when teachers are situated in the individualistic culture of teaching, their dispositions and practices are reflected and shaped mainly by their practical and personal experiences and beliefs about teaching. This individualistic teaching context may prevent teachers from exposing their teaching practices to their colleagues, and sharing and reflecting on each other's teaching practice (Feiman-Nemser & Floden, 1986; Little, 1990, 2003; Paine & Ma, 1993). In contrast, when teachers are situated in the collaborative teaching context of their work, they would demonstrate the characteristics as collectively reflecting teaching practices, examining new conceptions of teaching and learning, and actively engaging in collegial interaction (Little, 1990, 2003; Paine & Ma, 1993). Through the collaborations and

collegial interaction, teachers build trust and supportive relationships, and develop collective capacity and a combined sense of confidence and mutual obligation (Little, 2003).

Following this line of reasoning, I assumed that teacher self-efficacy and collective teacher efficacy possibly differ in different teaching contexts resulting from cultural influences such as in the U.S. and Chinese teaching contexts, which has been found largely differ from each other. The former has been considered as individualist while the later has been considered collectivist (e.g., Little, 1990, 2003; Paine & Ma, 1993; Wang & Paine, 2003). In the individualist teaching culture, instructional practice might be more likely influenced by teachers' self-efficacy rather than their collective teacher efficacy; in contrast, in the collectivist teaching context teachers' practice might be influenced more by their collective teacher efficacy rather than their self-efficacy because collective teaching activities may help teachers develop and strengthen their shared beliefs about knowledge of teaching and learning while the individualist culture may  help teachers develop and strengthen their individual beliefs of teaching and knowledge. These ideas were incorporated into the conceptual model that I developed to guide the examination of the relationship between teacher self-efficacy and collective teacher efficacy as well as their influences in the individualist and collectivist teaching contexts.

**Pedagogical Content Knowledge**

The third theoretical framework is grounded in the idea of pedagogical content knowledge (PCK) (Shulman, 1986) and its extended concept, such as mathematical knowledge for teaching (Ball, Thames, & Phelps, 2008) and Tatto et al.'s (2008) concept of pedagogical content knowledge for middle school mathematics teachers. According to Shulman (1986), pedagogical content knowledge can be defined as teachers' "understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of

different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons" and it is "the particular form of content knowledge that embodies the aspects of content most germane to its teachability" (Shulman, 1986, p. 9), which is central to quality of teaching in the content area.

Ball and her colleagues (2008) further developed a practice-based theory of mathematics knowledge for teaching based on Shulman's (1986) concept of pedagogical content knowledge. They defined "mathematical knowledge for teaching" as "the mathematical knowledge needed to carry out the work of teaching mathematics" (p. 395). Based on the analyses of mathematical needs of teaching, they argued that Shulman's PCK could be grouped into *knowledge of content and students* (KCS) and *knowledge of content and teaching* (KCT). Central to the knowledge needed for teaching, *knowledge of content and students* (KCS) is the knowledge that combines knowing about students and knowing about mathematics and *knowledge of content and teaching* (KCT) combines knowing about teaching and knowing about mathematics, which requires teachers to make pedagogical decisions about the design of instruction (Ball et al., 2008).

Ball et al. (2008) argued that to teach mathematics effectively, the mathematical demands of teaching deserve full consideration and teachers need to know more and different mathematics. As Grossman (1990) observed, these ideas:

> are inherent in Dewey's admonition that teachers must learn to 'psychologize' their subject matter for teaching, to rethink disciplinary topics to make them more accessible to students. . . . Teachers must draw upon both their knowledge of subject matter to select appropriate topics and their knowledge of students' prior knowledge and conceptions to formulate appropriate and provocative representations of the content to be learned. (p. 8)

Similarly, Tatto and colleagues (2008) also proposed that pedagogical content knowledge should include the knowledge for planning for mathematics teaching and learning and knowledge for enacting mathematics for teaching and learning. The pedagogical content knowledge that Tatto and colleagues (2008) proposed is consistent with Shulman's (1986) and Ball et al.'s (2008) notions of pedagogical content knowledge. The research group of Teacher Education and Development Study in Mathematics (TEDS-M) at Michigan State University developed a measure to examine mathematics knowledge for teaching of secondary mathematics prospective teachers in 17 educational systems. I used items from this instrument to assess middle school teachers' pedagogical content knowledge (Tatto et al., 2008) and Tatto et al.'s notion of pedagogical content knowledge as the base of this study, with the consideration of Shulman's (1986) and Ball et al.'s concept of pedagogical content knowledge. The above ideas of PCK were incorporated into the conceptual model that I developed to guide the examination of teachers' pedagogical content knowledge and its relationships with teacher self-efficacy and collective teacher efficacy in different contexts of teaching.

**Conceptual Model of the Study**

Based on the above three theories and relevant assumptions, I proposed a hypothesized conceptual model for this study (see Figure 1), which presented the relationships among teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge in two different assumed teaching contexts. In this conceptual model, there are two types of assumed teaching contexts, individualist and collectivist teaching contexts. Teacher self-efficacy and collective teacher efficacy may relate to each other in these two different teaching contexts. The strength and extent of the relationship between teacher self-efficacy and collective teacher efficacy may differ from one teaching context to the other. Teacher self-efficacy and collective

teacher efficacy may relate to teachers' pedagogical content knowledge independently or interactively. However, the strength and extent of the relationship between teacher self-efficacy and collective teacher efficacy may also vary in different teaching contexts of Chinese and U.S. schools.

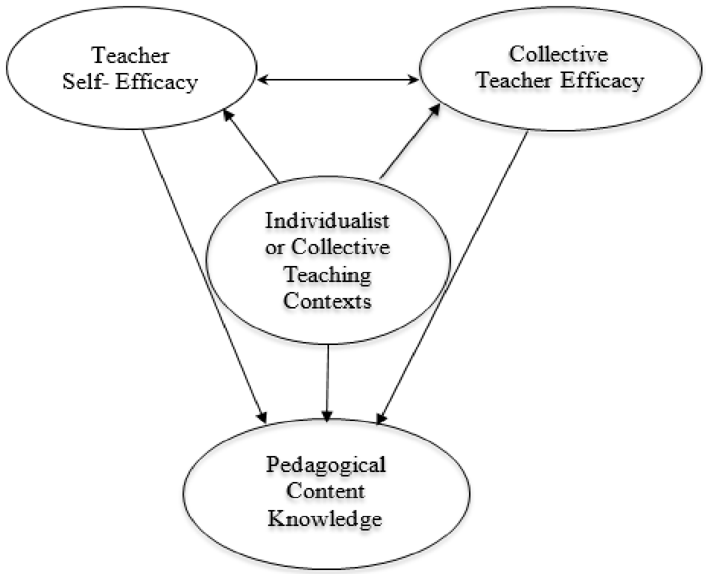


Figure 1: Conceptual Model of Interrelationships among Teacher Self-Efficacy, Collective Teacher Efficacy, and Pedagogical Content Knowledge

## Literature Review

To understand whether and to what extent each research question has been examined in the relevant literature and to identify the gaps and limitations in this body of empirical studies of each question, I conducted an empirical literature review as followed. First, I conducted an empirical literature search in three ways. I searched three data bases: *Education Resources Information Center* (ERIC), *PsycARTICLES*, and *PsycINFO*, which include peer-review journals in education and the American Psychological Association's psychology database indexes journal articles, books and dissertations, using the following terms "teacher or teachers" and "efficacy or self-efficacy" or "teacher or teachers" and "collective efficacy", "teacher knowledge" and

"efficacy", and "teacher knowledge" and "mathematics" in article titles rather than as keywords so as to ensure that the central focus of each article involves teachers' self-efficacy or collective teacher efficacy or teacher knowledge, and to avoid any articles irrelevant to the research questions of this study. Then, I searched for relevant empirical studies in five American Educational Research Association (AERA) journals: *American Educational Research Journal* (AERJ); *Educational Evaluation and Policy Analysis* (EEPA); *Educational Researcher* (ER); *Review of Educational Research* (RER); *and Review of Research in Education* (RRE) since the 1980s with the emergence of the term of the self-efficacy in the literature (Bandura, 1977). Another reason to choose these five AERA journals is because these journals publish highly respected leading research and current developments in these fields. In addition, I also searched the relevant articles in *Journal of Teacher Education* and *Teaching and Teacher Education* because these two journals publish studies on teaching and teacher education nationwide and internationally. This process helped me identify approximately 402, 32, and 142 empirical studies from the literature sources related to teacher self-efficacy, collective teacher efficacy, and mathematics teacher knowledge, respectively.

Second, I used the following criteria to screen the identified articles with K-12 teachers' self-efficacy, collective teacher efficacy, or pedagogical content knowledge as a focus of the study. The articles included in the literature review were exclusively *empirical studies* published in peer-reviewed journals (not reviews, theoretical articles, theses or dissertations, or meta-analyses), which examined teachers' self-efficacy or collective teacher efficacy or pedagogical content knowledge for teaching. The participants of the study were *in-service teachers in K-12 schools,* and the studies were conducted in either individualist or collectivist teaching contexts or both. The reference sections from the articles were used to determine additional studies for hand

searching. Finally, articles that met the above criteria were selected for the review. This screening resulted in 16 empirical studies.

Third, I reviewed and categorized each of the studies in the following ways. First, I organized the studies into four groups based on four research questions of this study. Second, for each study, I briefly reviewed its purpose, participants, measurements, and results. Third, for each group, I synthesized the commonality of the studies and the gap needed for further exploration and proposed my research questions to address the literature gap. This review process yielded three categories: (1) the relationship between teacher self-efficacy and collective teacher efficacy, (2) the impacts of teacher self-efficacy and collective teacher efficacy on instructional practices, and (3) the relationship between teacher efficacy and teacher knowledge.

**Relationship Between Teacher Self-Efficacy and Collective Teacher Efficacy**

To examine the relationship between teacher self-efficacy and collective teacher efficacy, this section reviewed four studies that investigated the connection between teacher self-efficacy and collective teacher efficacy in the different educational contexts in Hong Kong, Norway, and the US. These studies concluded with the finding of a positive relationship between teacher self-efficacy and collective teacher efficacy as identified in various contexts.

Kurz and Knight (2004) explored the relationship among individual teacher efficacy, collective teacher efficacy and goal consensus/vision. Surveys were administrated to 113 high school teachers who taught a variety of subjects. Gibson and Dembo’s (1984) shortened version of 16-item Teacher Efficacy Scale (TES) was used to measure individual teacher self-efficacy. Goddard et al.’s (2000) 21-item Collective Teacher Efficacy Instrument (CTEI) was used to measure collective teacher efficacy. The correlational analysis indicated a statistically significant positive relationship between individual teacher efficacy and collective teacher efficacy. The

authors cautioned that the moderate correlation between the two types of teacher efficacy may suggest that separate factors at school might have influenced teachers' individual and collective teaching efficacy.

Drawing on the data of 273 Chinese preservice and in-service teachers enrolled in a secondary teacher education program in Hong Kong, Chan's (2008) study explored the relationships among different teachers' self-efficacy beliefs. A 10-item general teacher self-efficacy scale (GTSES) and a 12-item collective teacher self-efficacy scale (CTSES, Schwarzer et al., 1999a) were used to assess collective teacher self-efficacy. Another 21-item version of the domain-specific teacher self-efficacy scale (DSTSES, Chan, 2008) was used. The results of correlational analysis among general, collective, and the seven domain-specific teacher self-efficacies indicated that teacher self-efficacy was significantly correlated with collective teacher efficacy. The researchers argued that the relationship between teacher self-efficacy and collective teacher efficacy could be better understood in the domain-specific context.

Drawing on a survey of 244 Norwegian teachers from 12 elementary and middle schools ($1^{st}$ to $10^{th}$ grade), Skaalvik and Skaalvik (2007) examined relations among teacher self-efficacy, perceived collective teacher efficacy, external control (teachers' general beliefs about limitations to what can be achieved through education), strain factors, and teacher burnout. A 24-item *Norwegian Teacher Self-Efficacy Scale* (NTSES, with six subscales: Instruction, Adapting education to individual students' needs, Motivating students, Keeping discipline, Cooperating with colleagues and parents, and Coping with changes and challenges) was used to measure teacher self-efficacy and perceived collective teacher efficacy, and a 7-item Perceived Collective Teacher Efficacy was employed to assess these relevant constructs. The results from a series of regression analyses and structural equation modeling analysis indicated that teacher self-efficacy

was also strongly related to perceived collective teacher efficacy ($r$ = .64). Results from multiple regressions indicated that perceived collective teacher efficacy was moderately related to all NTSES subscales ($\beta$ values between .27 and .39). This study suggests that teacher self-efficacy and perceived collective teacher efficacy should be treated as separate constructs. Another important finding is that these two constructs are positively and moderately related. Despite the possible reciprocal or causal relationships between the two constructs of teacher efficacy, the authors manipulated the structural equation modeling analysis to allow perceived collective teacher efficacy to predict teacher self-efficacy.

Goddard and Goddard (2001) conducted a study on the relationship between teachers' individual and collective efficacy from a survey of 452 teachers in 47 elementary schools in a large urban school district of the mid-western United States. Teacher self-efficacy was measured using a five-item personal teacher efficacy scale based on Gibson and Dembo's (1984) teacher efficacy scale. A 21-item collective efficacy scale was used to assess collective teacher efficacy. The hierarchical linear modeling (HLM) was employed to investigate the between-school variation in teacher efficacy. After allowing each of the five variables of students' mean SES, minority concentration, school size, and students' mean prior achievement, and collective efficacy to enter the equation separately, the authors identified students' mean scores of SES, prior mathematics achievement, and collective teacher efficacy as significant predictors of variation among schools in teacher self-efficacy. The results showed that with a one standard deviation increasing in collective efficacy, a 0.248 points increase was shown in teacher self-efficacy. And if considering students' mean SES and students' mean prior mathematics achievement, along with collective teacher efficacy, collective teacher efficacy was the only significant predictor of differences between schools in teacher self-efficacy. The results revealed

that collective teacher efficacy predicted variation in teacher self-efficacy above and beyond the variance accounted for by students' socioeconomic status and student achievement.

Using methods of correlational analysis, multiple regressions, structural equation modeling, and hierarchical linear modeling, these four studies enhanced our understandings of the relationship between teacher self-efficacy and collective teacher efficacy in different educational systems. All four of the studies confirmed that collective teacher efficacy and teacher self-efficacy are somewhat independent constructs but they are reciprocally related to each other. However, several problems exist for this body of the literature. First, none of them focused on a specific subject area. Therefore, it is difficult to generalize that the pattern of this relationship exists for mathematics teachers. Second, the different research instruments used in these studies made it difficult to compare the results across the studies to examine the extent of the relationship between teacher self-efficacy and collective teacher efficacy. Third, there was no specification of the educational context regarding whether the study was situated in an individualist or collectivist school contexts. Therefore, it is still unclear whether and to what extent the relationship between teacher self-efficacy and collective teacher efficacy will remain the same when the individualist and collectivist teaching contexts and specific mathematical teaching are considered. This study was designed to address these problems by exploring the relationship of teacher self-efficacy and collective teacher efficacy in the individualist and collectivist contexts of mathematics teaching.

**Influences of Self-Efficacy and Collective Teacher Efficacy on Instructional Practices**

This section reviewed existing empirical studies of the impacts of teacher efficacy on different aspects of instructional practices, which involved teacher efficacy and teacher professional commitment to teaching or students, teacher self-efficacy and attitudes toward

instructional innovations, and teacher efficacy and instructional practices. This review led to several significant conclusions.

First, three studies showed that teacher self-efficacy or collective teacher efficacy significantly predicted teacher professional commitment to teaching or students. To explore whether and to what extent teacher efficacy predicts teachers' commitment to teaching, Coladarci (1992) conducted a study with a sample of 170 K-8 teachers. The Gibson and Dembo (1984) instrument and two items from RAND were used to assess teacher efficacy, and in addition the question "*Suppose you had it to do all over again: In view of your present knowledge, would you become a teacher*?" was used to assess teacher commitment to teaching. The higher scores on this 5-point Likert scale indicated a greater likelihood of again selecting teaching as a profession. Multiple regressions were conducted to regress teacher commitment to teaching on teacher efficacy, as well as teacher background information, such as gender, teaching experience, teacher-student ratio, and salary. The results showed that, of independent variables, the two teacher self-efficacy constructs of general and personal efficacy were identified to be the two strongest predictors of teacher commitment to teaching. The author argued that characteristics of school organization that build teacher self-efficacy may promote teachers' commitment to the organization, and, in turn, to teaching.

To examine how teachers' individual and collective efficacy beliefs predict teachers' professional commitment, Ware and Kitsantas (2007) reanalyzed the data from Schools and Staffing Survey (SASS) in 1999-2000. Multiple regressions were conducted to regress teacher's commitment to teaching on teacher efficacy by including the 26,257 teachers who completed the SASS 1999-2000 teacher questionnaire in the data analysis. The results showed that all three efficacy scales were significant predictors of teacher commitment to teaching and thus, the

authors suggested that a moderate relationship exists among teacher efficacy, collective efficacy, and teacher commitment.

In another study, Lee, Zhang, and Yin (2011) explored the relationships among professional learning community, faculty trust in colleagues, collective teacher efficacy, and teachers' commitment to students with a sample of 660 teachers (around 20 teachers were randomly selected from each school) from 33 randomly selected primary (Grades 4-6) and secondary (Grades 7-9) schools in Hong Kong. Four translated Chinese instruments from the Tschannen-Moran and Barr's (2004) collective teacher efficacy scale, the Professional Learning Communities Assessment, and the Omnibus Trust scale, and the 8-item measure to teachers' commitment to students were administrated to all teachers in this study. The findings from the two-level hierarchical linear modeling (HLM) revealed that teachers' collective efficacy on instructional strategies ($\beta = 0.57$, $p < 0.001$) and on student discipline ($\beta = 0.69$, $p < 0.001$) significantly and positively predict teachers' commitment to students at school level.

Although showing that teacher self-efficacy or collective teacher efficacy significantly predicted teacher professional commitment to teaching using surveys to assess teacher efficacy and/or collective teacher efficacy and applying multiple regressions (Coladarci, 1992; Ware & Kitsantas, 2007) or hierarchical linear modeling (Lee, Zhang, & Yin, 2011), these three studies share a similar problem in the assumptions. All studies assume that teacher professional commitment to the teaching profession, school, colleagues, parents, and students as the key feature of quality of teaching (Coladarci, 1992; Lee, Zhang, & Yin, 2011; Ware & Kitsantas, 2007). However, teachers' commitment to teaching and profession does not necessarily warrant that teachers are willing and are able to know what they teach and how to teach effectively, and

how to ultimately improve student achievement. In addition, none of these studies focused on a specific subject area and a teaching context.

Second, three studies identified the positive connections between teachers' efficacy beliefs and their positive attitudes toward instructional innovations. The study by Guskey (1988) examined teacher self-efficacy, self-concept, and attitudes toward the implementation of instructional innovation. Four questionnaires were administered to 120 elementary and secondary school teachers immediately following a one-day staff development program on mastery learning instructional strategies. Results of correlational analysis showed that the more efficacious teachers (as measured by the RAND items) tended to rate mastery learning as more important, more congruent with their present teaching practices, and less difficult to implement, but no significantly relation with the cost was found. Assuming that if teachers reported a high level of personal efficacy their teaching abilities are highly effective in the classroom, Guskey (1981, 1988) argued that these teachers also tend to be more positive and receptive to the implementation of new instructional practices associated with mastery learning. The teachers who were less efficacious, on the other hand, seemed to be less positive and receptive to such innovation.

Drawing on the data from16 middle school teachers and nine high school teachers who participated in a four-day staff development program on cooperative learning method of Student Teams Achievement Divisions (STAD), Ghaith and Yaghi's (1997) study examined the difference between the low and high personal teaching efficacy teachers in their perception of the congruence, cost, importance, and difficulty of implementing STAD. A16-item instrument developed by Gibson & Dembo (1984) was to assess teacher personal teaching efficacy and general efficacy and Guskey's (1988) measure of teachers' attitudes toward the implementation

of instructional innovation was administrated to these 25 teachers immediately after the completion of the professional development training. The results indicated that, compared with less efficacious teachers, more efficacious teachers viewed STAD to be more important. There was no significant difference between groups of low and high efficacious teachers with regard to their perceptions of the cost and difficulty of implementing STAD. Teachers' general efficacy did not generate any significant effects on their perceptions of the congruence, cost, difficulty and importance of implementing STAD. The authors argued that the study supported the idea that enhancing personal teaching efficacy would function as a strong determinant of teachers' willingness to adopt new instructional practices.

In the third study, Charalambous and Philippou (2010) examined to what extent teachers' self-efficacy beliefs about using the reform instructional approaches affect their task and impact their concerns; and to what extent teachers' self-efficacy beliefs regarding pre-reform instructional approaches affect their self, task, and impact concerns. This study introduced one of aspects of efficacy beliefs, namely, teachers' efficacy beliefs to teach without using the reform. A total of 151 elementary mathematics teachers were asked to complete a questionnaire of their concerns and efficacy beliefs about this educational reform. The results from structural equation modeling showed that the teachers with more confidence in using the reform to teach problem solving had less intense management and consequence concerns. The results also indicated that teachers who felt more efficacious in using the reform tended to be less critical to the reform. In contrast, the more confident teachers who did not follow the reform received more intense management and consequence concerns. Teachers who reported higher efficacy to teach problem solving without using the reform also tended to be more critical of the reform, even though they also reported higher levels of efficacy to use the reform in their teaching; this group of teachers

also tended to report higher levels of reform awareness. Teachers' efficacy beliefs about using the reform affected their task and impact concerns; and efficacy beliefs about employing pre-reform instructional approaches influenced all types of teacher concerns. The results suggested that teachers who were more comfortable with pre-reform approaches tended to be more critical to the reform, exhibited more intense concerns about their capacity to manage the reform, and were more worried about its consequences on student learning.

Although helping identify teachers' attitudes toward educational reforms and the possible influences of teacher efficacy on attitudes, limitations in these studies justify the necessities of future studies. First, the relatively small sample size, especially Ghaith and Yaghi's (1997) study, may hinder the understanding of a big picture of the impacts of teacher efficacy on instructional practices. Second, these studies were built on an unsupported assumption that if teachers tend to have more positive attitudes toward educational innovation, they would be more likely to adopt new instructional practices and teach well. Third, none of these studies considered the influences of a particular teaching context on their results. This proposed study was designed to explore the relationships of teacher self-efficacy and collective teacher efficacy with teacher knowledge in schools with individualistic and collective teaching contexts.

Third, three studies yielded mixed and conflicting findings regarding the relationships between teacher self-efficacy and observed teaching practices or instructional choice. Brown (2005) conducted a study on the relationships among early childhood teachers' sense of self-efficacy, beliefs about the importance of mathematics, and mathematics instructional practices drawing on 94 prekindergarten teachers and educators from a large, metropolitan school district. The instructional practices of 20 mathematics teachers were subsequently observed by using an observational instrument of the Standards Observation Form (SOF) designed based on the

NCTM’s *Professional Standards for Teaching Mathematics* (NCTM, 1991) to assess how teaching meets the professional standards. The 24-item Teachers’ Sense of Efficacy Scale developed by Tschannen-Moran and Woolfolk Hoy (2001) was used to assess teacher efficacy in instructional strategies, classroom management, and student engagement. Meanwhile, the 54-item Teacher Beliefs in the Early Childhood Classroom instrument developed by Kowalski et al. (2001) was administrated to measure teachers’ beliefs about the importance of mathematics. The results of correlational analysis indicated that while teachers’ mathematics beliefs were correlated with overall teacher efficacy and with three efficacy subscales of student engagement, instructional strategies, and classroom management, teacher efficacy and teachers’ mathematics beliefs were not related to observed mathematics teachers’ teaching practices measured by the extent of how teaching practices meet the professional standards. The findings indicated an inconsistency of the thought that what teachers feel confident about or what they believe may be reflected in their mathematics teaching practices.

Flowerday and Schraw (2000) examined the direct linkage between teacher beliefs and instructional choice using the phenomenological approach of qualitative design. Drawing on in-depth interview data with 36 practicing teachers, the authors explored the phenomenon of instructional choice, and uncovered what, when, where, and to whom teachers offer instructional choice. The teacher participants taught different subjects and grades at elementary and secondary schools. Data were collected through seven interview questions. Three emerged themes were teacher beliefs about instructional choice, including types of choice, criteria for choice, and rationale for choice. The results showed that the amount of choice that teachers gave to students changed as teachers’ teaching experiences increased and the enhancement of their efficacy. Teachers who taught physical or biological sciences and mathematics tended to offer fewer

choices overall than teachers who taught arts and social sciences. This study suggests that teacher efficacy was one of the important determinants of decision making about instructional choice. However, the authors cautioned that whether high efficacy teachers offer more choices to their students than low efficacy teachers needs more evidence.

Recently, utilizing large international data of mathematics teachers from five Asian countries/regions including Singapore, Hong Kong, Japan, Chinese Taipei, and Korea, Shi (2014) examined the relationship between teacher self-efficacy and their instructional practices. The results indicated that varied aspects of teacher efficacy in teaching mathematics were not always statistically and positively related to their instructional practices in engaging students. In addition, the patterns of the relationship between teacher efficacy in teaching mathematics and instructional practices were mixed and inclusive across these countries/regions. These findings challenge the theoretical assumption about the positive relationship between teacher efficacy and instructional practices and call for further studies.

These three studies explored the relationship between teacher efficacy, teaching practices, and instructional choice and yielded mixed and conflicting findings without consideration of the influences of teaching contexts and subject content. Brown's (2005) study failed to identify the significant relationship between teacher efficacy and teaching practices, Flowerday and Schraw's (2000) study found this connection existed between teacher efficacy and instructional choice, while Shi's (2014) study showed mixed results of the relationship between teacher efficacy in teaching mathematics and self-reported teaching practices across five Asian contexts. Shi (2014) identified the inconsistent patterns of the relationship between mathematics teachers' self-efficacy and teaching practices. The inconsistent findings from these studies call for a further

examination of the relationship between teacher efficacy and instructional practices in more specifically considering a subject area and school teaching contexts.

**Teacher Efficacy and Teacher Knowledge**

While no empirical study investigated the relationship between teacher efficacy and teachers' mathematical knowledge with K-12 teachers, two studies offered evidence for the positive relationship between preservice teachers' science knowledge and self-efficacy, and English teachers' knowledge and self-efficacy.

Schoon and Boone (1998) evaluated the relationship between science teaching efficacy and the number of alternative conceptions (misconceptions) held by 619 preservice elementary teachers. Two instruments of the Elementary Science Teaching Efficacy Belief Instrument (STEBI-B) and a multiple-choice test for preservice teachers' science knowledge -- common alternative conceptions of science were administrated to these preservice teachers during the first weeks of their science methods classes to assess their science teaching efficacy beliefs and science knowledge. The stochastic Rasch model was used to evaluate these data and a *t*-test was used for comparing the differences. By comparing levels of science teaching efficacy to the number of correct responses on the alternative conceptions measures, they found that preservice teachers who selected the highest number (nine or more) of correct answers had significantly higher self-efficacy measures than those with the fewest correct answers (three or less), $p < .01$. The study also found no significant relationship between the number of alternative conceptions that teachers held and teachers' science teaching efficacy. However, holding of certain alternative conceptions (knowledge) was also found to be associated with low self-efficacy. The results showed that participants who held five specific alternative conceptions were significantly more likely to have a *lower* feeling of self-efficacy. These results indicated a strong connection

between the role of knowledge in science and science teaching efficacy beliefs.

Zakeri and Alavi (2011) explored the relationship between 55 novice English teachers' knowledge and their self-efficacy who had six month or less teaching experience at language institutes in Tehran. The Teacher Self-Efficacy Scale (TSES) (Tschannen-Moran & Woolfolk Hoy, 2001) and the Teaching Knowledge Test (TKT) was used to assess teachers' self-efficacy and pedagogical content knowledge. The TKT comprised three modules which measure 1) knowledge of terms commonly used in English language teaching, knowledge of factors basic to the learning of English by speakers of other languages, and knowledge of the range, function and appropriateness of the pedagogic choices; 2) planning lessons and using resources for language teaching and knowledge of how to employ resources; and 3) understanding of the functions of classroom language, adapting teacher language to learner characteristics and learning purpose, and recognition of learner error. The module also tests teachers' knowledge of the range and function of the strategies available to them for effectively managing classes. The results of series of Pearson product-moment correlation indicated that the correlation coefficients between the total knowledge score and total efficacy scores, as well as between the two subscales of teacher efficacy: class management and efficacy for instructional strategies, were statistically significant. However, the relationship between total knowledge score and efficacy for student engagement was not statistically significant. Also the results revealed that the first module of language and background to language learning and teaching had a positive significant relationship with the efficacy for classroom management ($r = 0.390$, $p < 0.01$) and efficacy for instructional efficacy ($r = 0.396$, $p < 0.01$) but not with efficacy for students' engagement. The second module of lesson planning and use of resources for language teaching had a significant relationship only with the efficacy for instructional strategies ($r = 0.297$, $p < 0.05$). The third module of managing

the teaching and learning process had a positive significant relationship only with efficacy for instructional strategies ($r = 0.299$, $p < 0.05$), but not with the efficacy for classroom management and efficacy for students' engagement.

Recently, a study (Martinussen, Ferrarim Aitken, & Willows, 2015), conducted in a Canadian urban university, examined the relations among 54 preservice teachers' perceived and actual knowledge of phonemic awareness, exposure to phonemic awareness instruction during practicum, and self-efficacy for teaching phonemic awareness. Martinussen et al. (2015) found that perceived knowledge of phonemic awareness was significantly and positively related with preservice teachers' self-efficacy for teaching phonemic awareness, while actual knowledge of phonemic awareness was not significantly correlated with perceived knowledge or self-efficacy ratings.

Although showing the positive relationship between preservice teachers' science and English knowledge and their self-efficacy, the first two studies (Schoon & Boone, 1998; Zakeri & Alavi, 2011) relied heavily on self-report measures on their knowledge and correlational analysis without any suggestion about the causal relationship. None of these three studies explored this relationship with mathematics teachers in different in-service teaching contexts. In addition, they failed to directly examine teachers' knowledge for teaching and student learning--an important area to be investigated.

The literature review informed fundamental issues in all the studies of teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge. None of these studies explored the individualist and collectivist teaching contexts and specific mathematical teaching with in-service mathematics teachers. The review called for studies on the relationship between teacher efficacy and knowledge of teaching in a specific subject area in different

contexts of teaching. The review also justified the importance of the research on teacher pedagogical content knowledge with K-12 in-service mathematics teachers, as well as the relationship between two types of teacher efficacy and pedagogical content knowledge in the individualistic and collective teacher contexts. For this reason, in this study, I examined the relationships among secondary mathematics teachers' self-efficacy, collective teacher efficacy, and teachers' mathematics pedagogical content knowledge for teaching with consideration of two different teaching contexts: Chinese and U.S. teaching contexts.

# CHAPTER 3 METHODOLOGY

## Research Design and Analytical Models

Built on the literature review and research questions of this study, a survey method was employed for the data collection of this study because of its efficiency and effectiveness in collecting quantitative data (Creswell, 2009). This method allowed me to gather cross-sectional information from larger samples of interested population, which is adequate and preferred for the exploration of the complex relationships among the three variables of teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge.

## Research Hypotheses

Based on the aforementioned three frameworks (social cognitive theory, situated learning perspectives, and pedagogical content knowledge) and their relevant assumptions, the research questions and the hypothesized conceptual model (see Figure 1), the hypothesized relationships among teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge proposed in this study were presented in Figure 2. Based on Figure 2, the four hypotheses of this study were as follows:

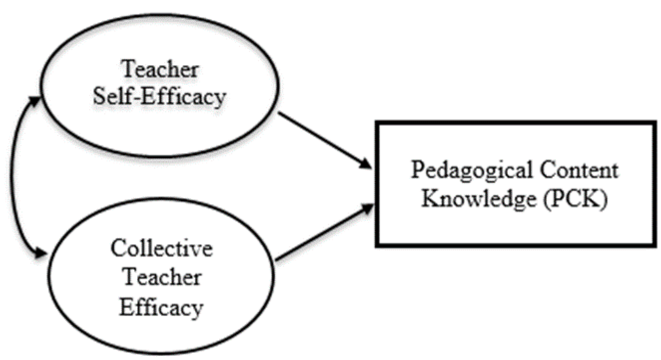


Figure 2: Hypothesized Relationships among Teacher Self-Efficacy, Collective Teacher Efficacy, and Teachers' Pedagogical Content Knowledge

**Hypothesis 1**. In response to the first research question, *Does Chinese mathematics teaching context significantly differ from the U.S. mathematics-teaching context*, I hypothesized that there is a significant difference regarding Chinese and U.S. mathematical teaching contexts due to a variety of factors of historical, political, social, and educational aspects (Little, 1990; Wang & Paine, 2003).

It might be a commonly accepted idea that teachers need a collegial professional learning community in which teachers can collaborate with each other in sharing beliefs, discussing effective ways of teaching, reflecting on teaching practices, and improving teaching quality and student learning (Putnam & Borko, 2000; Wang & Paine, 2003). However, due to the individualist and collectivist cultures in China and the US, teachers have developed different philosophies regarding collegiality and collaboration, which shaped school teaching contexts and teachers' teaching practice, accordingly (Klassen et al., 2008; Preus, 2007). In the literature of teacher education, such perspectives have been developed with regard to the relationship between a collegial professional learning community and teacher autonomy.

**Hypothesis 2**. In response to the second research question, *Whether and to what extent do teacher self-efficacy and collective teacher efficacy relate to each other in the individualist and collectivist teaching contexts*, I hypothesized that there is a positive relationship between teacher self-efficacy and collective teacher efficacy in a collectivist teaching context, while there is a weak positive relationship between teacher self-efficacy and collective teacher efficacy in an individualist teaching context .

This hypothesis stemmed from the literature that I reviewed in the previous section and Bandura's (1997) suggestion that efficacy beliefs depend on situational specificity; i.e., efficacy beliefs are determined by the situation or context relevant to the action or task. However, the

magnitude of the relationship between teacher self-efficacy and collective teacher efficacy may vary under different teaching contexts. Therefore, I further hypothesized that there is a mediate to a strong and positive relationship between teacher self-efficacy and collective teacher efficacy in the collectivist teaching context, whereas there is a weak but positive relationship between teacher self-efficacy and collective teacher efficacy in an individualistic teaching context.

**Hypothesis 3**. To address the third research question, *Whether and to what extent does teacher self-efficacy relate to teachers' pedagogical content knowledge in the individualist and collectivist teaching contexts*, I hypothesized that there is a strong and positive relationship with teacher self-efficacy and pedagogical content knowledge in a collectivist teaching context, whereas there is a weak but positive relationship between collective teacher self-efficacy and collective teacher efficacy in an individualist teaching context.

The social cognitive theory builds its assumptions in a view of human agency in which individuals or groups can proactively engage in their success and development and "can largely determine the outcomes of their actions" (Schunk & Pajares, 2009, p. 36). Based on the existing studies, teachers' self-efficacy was found to influence teachers' instructional behaviors (Ghaith & Yaghi, 1997; Gibson & Dembo, 1984; Tschannen-Moran, Hoy, & Woolfolk Hoy, 1998), such as instructional choice (Flowerday & Schraw, 2000), and attitudes toward new methods in teaching (Ghaith & Yaghi, 1997). Following this assumption, teacher self-efficacy will influence the essential components of teachers' instructional practices – teachers' pedagogical content knowledge.

**Hypothesis 4**. To address the fourth research question, *Whether and to what extent does collective teacher efficacy relate to teachers' pedagogical content knowledge in the individualist and collectivist teaching contexts*, I hypothesized that there is a strong and positive relationship

between collective teacher efficacy and pedagogical content knowledge in a collectivist teaching context, whereas there is a weak but positive relationship between collective teacher efficacy and pedagogical content knowledge in an individualist teaching context.

Collective teacher efficacy is collective beliefs about their capabilities to produce effects and the beliefs are shared among people of same social obligations or interests, which is assumed a strong predictor of school effectiveness (Bandura, 1993, 1997; Goddard, Hoy, & Woolfolk Hoy, 2000). The studies suggest that the culture and norms of each school, as perceived collective teacher efficacy, may exert a strong influence on teachers' instruction. Therefore, it is reasonable to hypothesize that collective teacher efficacy may also relate to teachers' pedagogical content knowledge.

**Educational Contexts of the Study**

The selected participants from middle schools in China and the US were included in this study to test the hypothesized relationships among teacher self-efficacy, collective teacher efficacy, and teacher's pedagogical content knowledge. Chinese mathematics teachers teach in a context of teaching resembling the collectivist context required for examination of the research questions in this study. Teachers in China have the tradition of being organized to plan and implement lessons following the centralized curriculum by working with each other in a teaching and research group (known as *jiaoyanzu*) as a unit, through which they are organized to regularly observe, evaluate, critique each other's mathematics lessons, and analyze student learning and grade students' tests or examinations collaboratively, as shown in a series of cases (e.g., Paine, 1997; Paine & Ma, 1993; Wang & Paine, 2003). Since all teachers are required to participate in the activities of the teaching and research group, it would anticipate a high degree of collegiality and collaboration among teachers in Chinese secondary schools (Bush, Coleman, & Si, 1998)

and this context would further deepen teachers' understandings of mathematics content and students' mathematical learning and influence teachers' knowledge and their instructional practices (Lewis, 2000; Paine, 1997; Wang & Paine, 2003). Therefore, it is reasonable to assume that Chinese teachers in general can more easily develop shared beliefs about mathematics teaching and learning to teach and consequently enhance their collective teacher efficacy to implement the new standards of mathematical educational reform. Consequently, teacher self-efficacy and collective teacher efficacy in this teaching context may closely relate to each other (see Figure 3b).

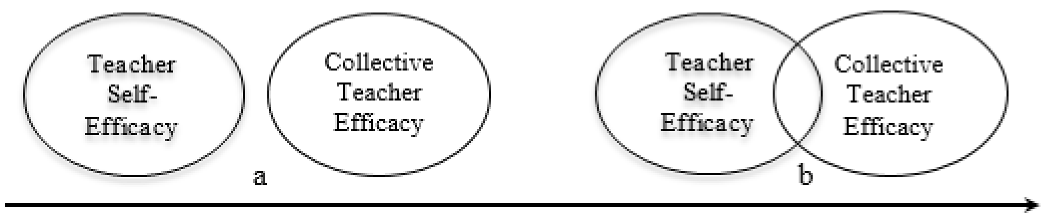


Figure 3: Hypothesized Relationship Between Teacher Self-Efficacy and Collective Efficacy in Individualist and Collectivist Teaching Contexts

In contrast, U.S. teachers tended to teach under the individualist culture of teaching that shares several characteristics in spite of the increasing external demands for teacher to work together to improve student achievement that occurred in a series of reforms (Puchner & Taylor, 2006). First, U.S. teachers lack shared common concepts and terms of teaching and learning to teach (Wang & Paine, 2003). This situation, for instance, may encourage teachers to give more considerations to their individual practical and personal experiences and ignore specialized professional knowledge when they are teaching (Carter, 1990; Clandinin & Connelly, 1995). Second, the individualistic organization of teaching is pervasive in U.S. school instructional contexts in which teachers work in an individual and isolated manner (Feiman-Nemser & Floden, 1986; Little, 1990, 2003; Lortie, 1975), which prevents U.S. teachers from sharing,

observing, and examining each other's teaching practices collaboratively. Third, this individualist culture does not encourage teachers to conduct pedagogical reflections with their colleagues on their instructional practices and learn to use professional knowledge as a guide in their teaching (Carter, 1990; Feiman-Nemser & Buchmann, 1987). As a result, it is more difficult for U.S. teachers to develop shared beliefs about teaching and form collective teacher efficacy to implement the new standards of mathematical educational reform. Therefore, teacher self-efficacy and collective teacher efficacy in this teaching context may loosely relate to each other (see Figure 3a).

These contextual differences between the two countries offered two contrasting contexts for this study to investigate the relationship between teacher self-efficacy and collective teacher efficacy in order to understand how teacher efficacy relates to teachers' pedagogical content knowledge.

**Participants**

Participants of this study included mathematics teachers who taught $6^{th}$ to $8^{th}$ grades in the U.S. and China at the time of data collection. Considering the sensitivity of the chi-square of any model fit to the sample size (Byrne, 2006) in using the structural equation modeling to conduct a confirmative factor analysis, a total of 98 mathematics teachers from the U.S. and 384 from Chinese middle schools were included in this study based on the idea of the ratio of number of test items (Collective teacher efficacy has 23 items) and number of participants (e.g., 1: 5~10, Osterlind, 2010). I also considered teachers' demographic information, such as teaching experiences, certifications, and types of schools because I used the aggregated perceptions of an individual teachers' group-referent perceptions of group capabilities representing collective teacher efficacy in the assigned school.

Three reasons accounted for selecting the participants from the two countries. The first and the most important one, as mentioned in last section, was the different teaching contexts in China and the US. Second, earlier studies indicated that U.S. mathematics teachers differ markedly from their Chinese colleagues in teachers' mathematical content knowledge (Ma, 1999; Zhou, Peverly, & Xin, 2006) and pedagogical content knowledge (An, Kulm, & Wu, 2004; Zhou, Peverly, & Xin, 2006), both of which can be directly assumed to relate to teachers' instructional practices (Hill et al., 2008; Kersting et al., 2012; Putnam, Heaton, Prawat, & Remillard, 1992; Tchoshanov, 2011; Wilkins, 2008) and student mathematics achievement (Hill, Rowan, & Ball, 2005; Kersting et al., 2012). Third, empirical evidences from a large-scale international database of the Trends in International Mathematics and Science Study (TIMSS) also indicated that self-efficacy of U.S. fourth grade mathematics teachers ranked higher than that of their Chinese counterparts in Hong Kong and Chinese Taipei (Shi, Wang, & Zhang, 2011). Fourth, the knowledge difference has been viewed to be the reason for US and Chinese teachers' performance gap (e.g., An, Kulm, & Wu, 2004; Ma, 1999). The documented differences between U.S. and Chinese mathematics teachers regarding their mathematical knowledge (An, Kulm, & Wu, 2004; Ma, 1999; Zhou, Peverly, & Xin, 2006) and self-efficacy (Shi, Wang, & Zhang, 2011) established meaningful bases and useful contexts for me to explore the relationship between teacher efficacy and mathematics teacher's pedagogical content knowledge in the two different teaching contexts.

I chose to investigate middle school mathematics teachers based on the following considerations. First, the results from Mathematics Teaching in the 21$^{st}$ Century (MT21) found that U.S. preservice teachers of middle school mathematics are not well prepared to teach mathematics when compared with their international counterparts (Schmidt et al., 2007).

According to Schmidt et al. (2007), U.S. prospective middle school teachers prepared in the secondary teacher education program had the least learning opportunities than their international colleagues and their training of mathematics was similar to the training offered to prospective middle school teachers in the elementary education programs but “it is less by a sizeable amount (20 to 35 percent fewer advanced topics covered) than typical middle school prospective teachers’ prepared in the secondary program” (p. 8). These findings triggered researchers, policy makers, and teacher education program developers to find an answer to the question of whether preservice teachers of middle school mathematics are well prepared to teach middle school students. Second, secondary teachers both in China and the US typically teach one subject rather than several subjects as elementary teachers do in the US. Therefore, I closely examined teacher self-efficacy and teacher knowledge in one specific subject, which was mathematics in this study. Thus, with the focus on middle school mathematics teachers, this study offered empirical evidence of mathematical knowledge for secondary teacher education on a more balanced basis.

A total of 511 responses from U.S. and Chinese mathematics teachers were collected from 550 invitations. Of the 511 responses, 482 clear data remained after a cleaning process eliminated the incomplete responses ($n = 7$ for China, and $n = 22$ for the US). There was a 76.8% response rate for Chinese participants and a 65.3% response rate for U.S. participants. Finally, data from 482 mathematics teachers were included in the study, of which 98 participants from several middle schools in a large school district in the US and 384 mathematics teachers from 26 middle schools in several school districts in China were included in the data analysis. Table 2 presented the demographics of the participants (see Table 2). The average years of teaching as a mathematics teacher for U.S. teachers was 5.05 ($SD = 4.44$), ranging from 1 to 23, and the average years of teaching at the current school was 3.12 ($SD = 2.26$), ranging from 1 to 15. The

average years of teaching as a mathematics teacher for Chinese teachers was 13.95 (*SD* = 7.61), ranging from 1 to 38, and the average years of teaching at the current school was 9.62 (*SD* = 6.19), ranging from 1 to 38.

Table 2 Characteristics of Mathematics Teachers in the US and China

| Participants by Group[a] | | US (n = 98) | | China (n = 384) | |
|---|---|---|---|---|---|
| | | n | Percentage | n | Percentage |
| Gender | Female | 69 | 2 | 250 | 65 |
| | Male | 29 | 30 | 131 | 34 |
| Teaching Experiences | Less than a year | 25 | 26 | 19 | 5 |
| | 1-2 years | 22 | 22 | 16 | 4 |
| | 3-5 years | 17 | 17 | 28 | 7 |
| | 6-10 years | 24 | 24 | 135 | 35 |
| | Above 10 years | 10 | 10 | 163 | 42 |
| Training[b] | Mathematics | 21 | 21 | 115 | 30 |
| | Math Education | 33 | 34 | 137 | 36 |
| | Elementary Education | 39 | 40 | 18 | 5 |
| | Secondary Education | 7 | 7 | 41 | 11 |
| | Others | 6 | 6 | 0 | 0 |
| Degree | Associate | 1 | 1 | 15 | 4 |
| | Bachelor | 32 | 33 | 328 | 85 |
| | Masters | 65 | 66 | 25 | 7 |
| | Ph.D. | 0 | 0 | 9 | 2 |
| | Others | 0 | 0 | 3 | 1 |

Note: a: Some participants failed to indicate their demographic information. b: Some U.S. participants were trained in more than one subject areas.

**Instruments**

Three instruments were used to assess teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge, respectively. First, the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) for preservice teachers, developed by Enochs, Smith, and Huinker (2000) to measure mathematics efficacy beliefs of preservice teachers, was modified and used to measure teachers' self-efficacy in this study. This instrument consists of a total of 21 items on the scales of Personal Mathematics Teaching Efficacy (13 items) and Mathematics

Teaching Outcome Expectancy (8 items), which is validated based on the data of 324 preservice teachers, showing an alpha coefficient of internal consistency (Cronbach's alpha) of 0.88 for personal mathematics teaching efficacy scale. The confirmatory factor analysis (CFA) results revealed that the data fit the model adequately.

The survey with 13 items for assessing teacher self-efficacy in mathematics teaching was administered to Chinese and U.S. mathematics teachers because the survey directly measured mathematics teachers' self-efficacy. Since this instrument was originally designed for preservice teachers, I changed the future tense in the original statements to the present tense, for example, "I find it difficult to use manipulatives to explain to students why mathematics works". After exploratory analysis of the survey, two items were removed from the final survey because they did not closely measure teacher self-efficacy due to the lower loadings on their corresponding factors. Therefore, 11 items were retained in the final survey (see Appendix I Part 2 of its English version and Appendix II Part 2 for its Chinese version). The summary of the indexes of the measurement models for Chinese and the U.S. samples were presented in the Table 3 in the later section of "Data analysis".

Second, some items from the Collective Teacher Efficacy Scale (CTES), developed by Goddard, Hoy, and Woolfolk Hoy (2000), were used in this study. These items, designed to examine collective teacher efficacy, were used for this study to assess overall collective teacher efficacy. Item stems of the CTES reflect both the task analysis and group competence dimensions. Task analysis (TA) means "perceptions of the constraints and opportunities inherent in the task at hand" (Goddard, 2002a, p. 100) and includes teachers' beliefs about possible support provided by the students' home and the community. Group competence (GC) refers to teachers' "judgments about the capabilities that a faculty brings to a given teaching situation"

(Goddard, 2002a, p. 100), which consists of inferences about the faculty's teaching methods, skills, training, and expertise. In each dimension (task analysis and group-competence), items that are positively and negatively worded were included (Goddard, 2002a; Goddard et al., 2000). This instrument is validated based on 452 elementary school teachers, which showed that the CTES score was positively related to scores measured by similar constructs, such as aggregated teacher efficacy as assessed by Bandura's (2000) 10-item measure, and aggregated personal teacher efficacy assessed in Hoy and Woolfolk's (1993) study using a version of Gibson and Dembo's (1984) Teacher Efficacy Scale. The evidence indicates that this instrument (CTES) possesses acceptable concurrent validity. Additionally, collective efficacy was negatively related to teacher powerlessness and not related to environmental press, indicating its divergent validity. The instrument also had high internal reliability (alpha = .96). These results provided evidence that the collective teacher efficacy scale is valid and reliable.

I chose items on group-teaching competence (GC) in this instrument to assess collective teacher efficacy because GC matches the definition of collective teacher efficacy and the central ideas of this study in which views collective teacher efficacy as "a sense of collective competence shared among teachers." The corresponding version of CTES had been translated into Chinese and demonstrated acceptable validity and reliability in Liu, Zhang, and Meng's (2005) study. However, since the items from CTES were not focused on mathematics teaching originally, I revised the statement into the context of mathematical teaching. For example, "*Teachers in my department have what it takes to get the children to learn mathematics*".

In addition, items from Teacher Survey developed by the Center for Research on the Context of Teaching (CRC) at Stanford University (2010) were also adopted and modified to assess collective teacher efficacy because these items match the operational definition of

collective teacher efficacy about “collegiality and collaboration”. One item, for example, reads: “*Teachers in my department share their ideas of teaching with other teachers*.” Please see Appendix I Part 3 for its English version and Appendix II Part 3 for its Chinese version of Collective Teacher Efficacy surveys.

Since collective teacher efficacy assesses groups’ capabilities rather than those of individuals, the collective efficacy measure should be analyzed at the group level (Goddard, 2002a). Thus, instead of treating collective teacher efficacy as the group mean of self-referent perceptions or simply asking group members to estimate their group capabilities together as in many other studies (Goddard et al., 2004), I used the aggregate of individual teachers’ group-referent perceptions of group capabilities representing collective teacher efficacy in each teaching context because this approach matches the definition of collective teacher efficacy employed for this study as “a sense of collective competence shared among teachers”. Twenty-three items were included in the data analysis.

Third, I used the instrument, developed by Teacher Education and Development Study in Mathematics (TEDS-M) for measuring mathematics knowledge for teaching of secondary mathematics prospective teachers, to assess middle school teachers’ pedagogical content knowledge (Tatto et al., 2008). As a cross-national study of primary and secondary mathematics teacher education, the International Association for the Evaluation of Educational Achievement (IEA) sponsored TEDS-M. The lead institution of TEDS-M is The International Study Center at Michigan State University.

Several reasons accounted for the usage of this instrument in this study. First, the theoretical framework for developing the instrument of mathematics pedagogical content knowledge (MPCK) was built on Shulman’s (1986) notion and categories of pedagogical content

knowledge and Ball et al.'s (2008) conceptualization of mathematical knowledge for teaching, which is the similar one underpinning this study (selected from Tatto et el., 2008). TEDS-M defined mathematics pedagogical content knowledge (MPCK) as knowledge for planning for mathematics teaching and learning (pre-active) and knowledge for enacting mathematics for teaching and learning (interactive), which matches the ideas of pedagogical content knowledge for this study.

Second, the TEDS-M knowledge instrument was developed in consultation with cross-national teams of mathematicians, mathematics educators, psychometricians, and comparative research design experts (Tatto & Senk, 2011). Items were written and reviewed by researchers from TEDS-M countries and nonparticipating countries. Members of the TEDS-M management team at the Michigan State University wrote additional items. All items were selected by the condition of whether it should be kept in the instrument through piloting in five countries in 2006 and a major field trial of instruments and procedures conducted in 2007 (Tatto & Senk, 2011). These procedures ensure the content validity of the instrument.

TEDS-M developed the scales for mathematics and for mathematics pedagogical content knowledge by using item response theory (IRT) methods. Each test block of secondary mathematics in the test bank contains an average of 15 items of three choice questions that range from one to three points. Three formats of the TEDS-M questions include multiple choice (MC), complex multiple choice (CMC), and open constructed response (CR) (Tatto et al., 2008). Each multiple choice question adds one point toward scores and sub-scores. Complex multiple choice response items composite one question stem followed by a list of choices, each of which is scored as "*correct*" or "*incorrect*." Open constructed-response questions are scored from zero up to "*one*", "*two*", or "*three*" points depending on the depth of understanding. Approximately 74%

questions are multiple choice and complex multiple-choice responses, and the rest of them are open constructed response questions.

The instrument for assessing pedagogical content knowledge of secondary prospective teachers spanned four content domains, covering number, geometry algebra and data including in secondary mathematics curriculum. In addition, the items included questions about more advanced topics in each domain (e.g., irrational, real, and complex numbers, and topics from calculus, analysis, linear algebra, and abstract algebra in the algebra domain). The limited released items for lower secondary teachers consist of 9 MPCK items (5 for Algebra domain, 0 for Geometry, 3 for Number, and 1 for Data) illustrating the two sub-domains of Curriculum/Planning (4) and Enacting (5). Considering the level of mathematics in secondary schools, I adopted seven items of these released questions (see the Appendix I Part 4 for its English version and Appendix II Part 4 for its Chinese version).

The back translation technique, a commonly used translation method in cross-cultural research, was employed for the translation of all the surveys for this study to ensure the consistencies and matches between the English version and Chinese version. First, the English version of all the surveys for this study was translated initially into Chinese by a native bilingual Chinese educational researcher. Then another native bilingual Chinese educational researcher blindly translated the Chinese version of all the surveys back into English. After that comparisons between the translated English version and original English version were made to assure the accuracy. Followed modifications to the Chinese version more accurately reflect the conceptual meaning of the original English version. The final corrected Chinese version was administered to the participants in China (see Appendix II).

To summarize, the three modified instruments contain the necessary items that are related to teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge. As a result, the three modified instruments were used to measure the constructs of teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge in this study.

**Data Collection**

Upon the approvals of university Institutional Review Broad (IRB) and Clark County School District IRB, data were collected in spring and fall 2014 in China and the US. The survey package, along with the consent form and a letter to in-service mathematics teachers, was delivered to all potential participants. The participating schools were selected from one of the largest school districts in the US and several equivalent school districts that had implemented mathematics curriculum standards since 2009 in China. To match two groups of populations in the US and China, I considered the similarities of types of schools and their social economic status. A two-stage sampling strategy was used for this study. At the first stage, 10-15 middle schools were randomly selected from a convenient school district in each country; second, all mathematics teachers in selected schools were the potential participants of this study. Finally, 98 mathematics teachers from several middle schools in a large school district in the US and 384 mathematics teachers from 26 middle schools in several school districts in China were included in the data analysis.

**Data Analysis**

The quantitative methodology with several analytic approaches was employed for this study. Specifically, three analytic approaches, including chi-square test, analysis of variance (ANOVA), and correlation, were conducted to address four research questions proposed in the

current study. In addition, to ensure the measurements employed for this study were appropriate, structural equation modeling (SEM) was utilized to examine the constructs of the three surveys for each sample of U.S. and Chinese mathematics teachers before the data analysis. Although multi-group SEM might be suitable for the estimates across groups, which requires large sample sizes in each group (Bou & Satorra, 2010), the sample size for U.S. teachers was small in this study. Therefore, a separate CFA was conducted for each construct for each sample. SEM has been widely used in the field of educational research due to its ability to model latent variables and measurement errors simultaneously (Bentler & Chou, 1987). SEM not only can provide a parsimonious summary of the interrelationships among interested variables (Kahn, 2006), but also allows researchers to test hypothesized relationship between constructs (Weston & Gore Jr., 2006). A few software can be used to conduct such analysis, such as Linear Structure Relations (LISREL), Analysis of Moment Structures (AMOS), Equations (EQS), and Mplus. In this study, I utilized the EQS 6.3 program (Bentler, 2003) because of its availability.

Several steps were adopted to ensure the assumptions of the parametric analysis met. First, initial screening of the data was performed for each individual item and their composite scores. Second, confirmatory factor analyses (CFA) of three constructs, teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge for each sample, were conducted.

Before data analyses were conducted, the missing data were identified and replaced using expectation maximization (EM) imputation. Information in real research data is frequently lost, which presents missing values (MVs) in the targeted variable(s). MVs raise the issue in data mining and make data analysis difficult that requires a preprocessing procedure in which the MVs are properly handled (Luengo, Garcia, & Herrera, 2012). In fact, inappropriate handling of the MVs in the analysis may introduce biases and can result in misleading conclusions drawn

from a research study and can also limit the generalizability of the research findings (Wang & Wang, 2010). Among different approaches for handling MVs, one of the most commonly used approaches is EM imputation, in which maximum likelihood strategies can be used to create a new data set based on the observed data. These maximum likelihood strategies demonstrated superiority to simple deletion, nonstochastic imputation, and stochastic regression imputation methods (Roth, 1994), in which all missing values are imputed with maximum likelihood values based on observed relationships among all the variables (Acock, 2005). Since EM is an important advance over traditional approaches such as listwise deletion, pairwise deletion and mean substitution for multivariate normal distributions (Acock, 2005; Schlomer, Bauman, & Card, 2010), I used EM embodied in ESQ 6.3 for handling the missing values in this study. The final data used for this study were those without missing values on the targeted variables.

To estimate the parameters of the SEM model, although many procedures for SEM have been developed, the normal-distribution-based maximum likelihood (ML) estimation is still most widely used in practice, which may lead to reasonable parameter estimates and assessment of the overall model when data are approximately normally distributed. Therefore, it is necessary to examine the data and model to determine whether the ML procedure is adequate before proceed it because only when the sample does not contain obvious outliers can one trust the results of the ML-based analysis (Yuan & Bentler, 2001). The examinations of the data indicated that skewness and kurtosis for each item and its composite ranged from .011 to 1.68, and .045 to 2.6, respectively, and no obvious outliers were identified, suggesting that ML procedure is appropriate for this study.

In addition, a prior data analysis was to determine which ML estimation method will be used for each sample of U.S. and Chinese teachers, so examinations of skewness and kurtosis

(univariate and multivariate) were conducted before building measurement models of three surveys. If the data are normally distributed without skewness and kurtosis in standard deviation units ranging from +3 to -3 (Kline, 2005), the maximum likelihood will be appropriate for the data analysis. Otherwise, if the data are not normally distributed with skewness or kurtosis in standard deviation units with absolute value larger than three, robust maximum likelihood estimation will be appropriate for the data analysis. The results of such examinations indicated that the normalized estimate of teacher self-efficacy survey was 31.32 for Chinese data and was 14.72 for the U.S. data, and 63.16 for Chinese data and 15.69 for the U.S. data for the collective teacher efficacy survey, for the pedagogical content knowledge survey was 11.80 and 3.56 for the Chinese data and the U.S. data, respectively. All these estimates were larger than 3, suggesting that maximum likelihood robust estimation was appropriate for this study (Dimitrov, 2014).

Studies that apply ML also require adequate samples to run steadily. Bentler and Chou (1987) also suggested that ML requires a minimum of five respondents per constructed variable, while Hair et al. (2006) and Salaheldin (2009) advocated about 100 to 150 samples. Since the survey used in this study included 11, 23, and 5 items for teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge, respectively, the minimum 115 samples (5 x 23) should be achieved ideally. However, studies indicated the lack of Type I error in small samples (Hart Jr. & Clark, 1999). Therefore, with a sample of 98 U.S. mathematics teachers, I used maximum likelihood robust estimation to ensure a stable estimation.

To build the models for each sample, the fit of the measurement model of three constructs for each group was tested to evaluate whether the observed variables (indicators of the latent constructs measured for two set of data) were generated by their corresponding latent constructs.

The overall fit and the regression paths were analyzed for this purpose. A modification process was used to the measurement model for Chinese model since the marginal fit of the initial model to the data. The indexes of the goodness of fit between the hypothesized model and the data were examined to determine the adequateness of the model describes the two sets of data. Based on the results of the Lagrange Multiplier (LM) tests and Wald tests, and more importantly the theoretical consideration, the modification process followed was applied to the models for Chinese and the U.S. data, so that each model could be improved to fit the data adequately, and to be the parsimonious model.

The model fits of the three measures for Chinese and U.S. data were presented in Table 3. Overall, the results indicated that the models fit the data adequately based on the commonly accepted standards for comparative fit index (CFI), non-normed fit index/Tucker-Lewis index (NNFI/TLI), root mean-square error of approximation (RMSEA), and confidence interval (CI) (Bentler, 2003; Kline, 2005). The estimated reliabilities (Cronbach's alphas, α) ranged from .61 to .92 on the three measures for Chinese sample, and .86 to .93 for the U.S. sample, which were also acceptable for both samples (George & Mallery, 2003). Therefore, the three surveys used in this study were reliable and valid to measure teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge.

Table 3 Summary of the Three Measurement Models and Cronbach's Alphas

| Sample | Measure | S-B$\chi^2$ | *p* | CFI | NNFI | RMSEA | CI | α |
|---|---|---|---|---|---|---|---|---|
| Chinese | Self-efficacy | 77.46 | < .01 | .94 | .91 | .053 | .037~.070 | .77 |
| U.S. | | 49.17 | < .01 | .98 | .97 | .042 | .000~.084 | .85 |
| Chinese | Collective teacher efficacy | 60.62 | < .01 | .95 | .92 | .045 | .038~.052 | .94 |
| U.S. | | 192.96 | < .01 | .96 | .95 | .044 | .000~.066 | .92 |
| Chinese | Pedagogical content knowledge | 1.33 | > .05 | .99 | .94 | .035 | .000~.084 | .62 |
| U.S. | | 5.20 | > .05 | .99 | .98 | .087 | .000~.021 | .86 |

The second analytical approach utilized to answer the first research question of this study was chi-square test. The chi-square test has become one of well-used statistical analyses in educational research since its inception, which can be applied for testing goodness of fit, independence, and homogeneity (Franke, Ho, & Christie, 2012). Several chi-square tests were conducted to examine the proportional differences in terms of teachers' perceptions about two different teaching contexts on each item of collectivist and individualist teaching contexts.

Third, one-way analysis of variance (ANOVA) was performed to examine the mean differences between the two samples of Chinese and U.S. mathematics teachers regarding two different teaching contexts, teacher self-efficacy, collective teacher efficacy, as well as pedagogical content knowledge because ANOVA is appropriate for multiple dependent variables (Stevens, 2002). Although *t*-test is an option for such comparison, ANOVA allows for a robust test of equality of means (Shieh & Jan, 2013).

In addition, correlations were performed to address research questions 2, 3, and 4, respectively, to examine the relationships among teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge for each sample. For all aforementioned tests, the alpha level for statistical significance was set at .05.

**Limitation of the Study**

This study addressed the relationships among teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge. As any educational study, several limitations of this study should be noted here. First, the small sample size, especially U.S. mathematics teachers, and non-randomly selected participants may limit the degree to which the findings can be generalized to other mathematics teachers in China or the US. Because it was difficult to match the two samples from the US and China regarding teachers' heterogeneity,

interpretation and generalization of the findings to other settings should be cautioned because both samples were not representative. Second, the correlational analysis of the variables did not suggest an exclusive causal linkage. Future studies may consider other analytical approaches, such as regression and hierarchical linear modeling, to examine the complicate relationships of teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge. The third limitation was related to the instrument, especially the construct of pedagogical content knowledge. Specifying and measuring teachers' pedagogical content knowledge is relatively more difficult and complicated (Shechtman et al., 2010) than measuring teachers' content knowledge when the instrument includes a small number of items. It might be beneficial to incorporate qualitative measures, such as the classroom observation, interview, and reflective journal, with quantitative measures so that researchers can triangulate with different data sources and develop a whole profile of teachers' pedagogical content knowledge. As the National Mathematics Advisory Panel recommends, "more precise measures should be developed to uncover in detail the relationships among teachers' knowledge, their instructional skill, and students' learning, and to identify the mathematical and pedagogical knowledge needed for teaching" (NMPA, 2008, p. 38). In addition, this study mainly used teacher self-reported surveys as teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge data, which may not be able to warrant that they are the identical as identified from classroom observations or other data sources. Future studies may employ a variety of data sources, such as interviews with teachers about their self-efficacy and collective efficacy, and observation of how teachers teach a mathematics concept to students. Therefore, the qualitative data could provide richer data sources triangulating with quantitative data. Finally, due to the foci of this study, the comparisons across different teachers' demographics within the country were not performed, but

the comparisons might be also interesting to help examine the similarities and differences based on such variables within a country.

## CHAPTER 4 RESULTS

This chapter presented results of the four research questions of this study. The first section reported the differences and similarities between two teaching contexts for mathematics teachers in China and the US. The second section presented the mean differences of Chinese teachers and U.S. teachers regarding their teacher self-efficacy, collective teacher efficacy and pedagogical content knowledge. The third section reported the relationship between teacher efficacy and collective teacher efficacy for Chinese and U.S. teachers. The fourth section reported the relationship between teacher self-efficacy and pedagogical content knowledge, and the relationship between collective teacher efficacy and pedagogical content knowledge for both samples.

### Different Teaching Contexts

The analysis revealed that teaching context of Chinese mathematics teachers was significantly different from teaching context of the U.S. mathematics teachers in some ways yet similar in others. First, Chinese mathematics teachers were required more frequently to plan lessons together, observe each other's teaching, and critique each other's teaching and provide feedback than their U.S. colleagues.

Table 4 Key Features of Mathematic Teaching Contexts in China and the US

| | Chinese Teachers | | U.S. Teachers | | $\chi^2$ | *p* |
|---|---|---|---|---|---|---|
| | *No* | *Yes* | *No* | *Yes* | | |
| Use the same or similar curriculum materials | 11 (2.9%) | 373 (97.1%) | 5 (5.1%) | 93 (94.9%) | 1.22 | ns[1] |
| Have external assessments for student learning | 108 (28.1%) | 276 (71.9%) | 19 (19.4%) | 79 (80.6%) | 3.07 | ns |
| Discuss how to improve students' math learning | 22 (5.7%) | 362 (94.3%) | 5 (5.1%) | 93 (94.9%) | .058 | ns |
| *Plan lessons together* | 34 (8.9%) | **350 (91.1%)** | 27 (27.6%) | **71 (72.4%)** | 24.69 | < .001 |
| *Observe each other's teaching* | 9 (2.3%) | **375 (97.7%)** | 77 (78.6%) | **21 (21.4%)** | 309.48 | < .001 |
| *Critique each other's teaching and provide feedback* | 13 (3.4%) | **371 (96.6%)** | 87 (88.8%) | **11 (11.2%)** | 346.22 | < .001 |
| Discuss how to assess student learning | 37 (9.6%) | 347 (90.4%) | 10 (10.2%) | 88 (89.8%) | .029 | ns |
| Analyze student achievement data | 23 (5.6%) | 455 (94.4%) | 4 (4.1%) | 94 (95.9%) | .54 | ns |

Note: 1 ns means not significant.

As shown in Table 4, about 91% of mathematics teachers in China reported that they were required to plan lessons together, 98% of teachers reported that they were required to

observe each other's teaching, and 97% reported a requirement for critiquing each other's teaching and providing feedback, while the proportions for U.S. teachers were 72%, 21%, and 11%, respectively, *ps* < .01.

Second, there were also substantial differences between Chinese and U.S. mathematics teachers in rating the frequencies of how often they did their daily teaching activities with their colleagues. Based on Table 5, significant differences were found with regard to observing other's teaching, sharing and discussion effective instructional practices, other teachers observing teaching, critiquing other's teaching and providing feedback, and sharing beliefs about teaching and student learning. Chinese mathematics teachers indicated that they observed colleagues' teaching practices (*M* = 3.53 vs 1.66), other teachers observed their teaching practices (*M* = 3.25 vs 2.33), and critiqued each other's teaching and provided feedback (*M* = 3.36 vs 1.63) more frequently than their U.S. counterparts, *ps* < .01.

Table 5 Means and Standard Deviations of Teaching Contexts in China and the US

| **How often math teachers do the following?** | Chinese Teachers | | | U.S. Teachers | | | |
|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *SE* | *M* | *SD* | *SE* | *p* |
| Do lesson planning | 3.97 | 0.93 | 0.05 | 4.00 | 0.84 | 0.08 | ns[1] |
| *Observe other's teaching practices* | **3.53**[2] | 1.05 | 0.05 | 1.66 | 0.98 | 0.10 | **< .01** |
| *Share and discuss effective teaching practices* | 2.92 | 1.08 | 0.05 | **3.23** | 1.48 | 0.15 | **< .05** |
| *Other teachers observe your teaching* | **3.25** | 1.16 | 0.06 | 2.33 | 1.37 | 0.14 | **< .01** |
| Discuss how to improve student learning | 3.38 | 1.11 | 0.06 | 3.54 | 0.47 | 0.05 | ns |
| *Develop teaching materials or activities* | 2.86 | 1.29 | 0.07 | **3.64** | 1.19 | 0.12 | **< .01** |
| *Critique each other's teaching and provide feedback* | **3.36** | 1.08 | 0.06 | 1.63 | 1.08 | 0.11 | **< .01** |
| *Discuss how to assess student learning* | 3.25 | 1.10 | 0.06 | **3.66** | 0.93 | 0.09 | **< .01** |
| Analyze student achievement data | 3.23 | 0.87 | 0.04 | 3.25 | 0.81 | 0.08 | ns |
| *Share beliefs about teaching and students' learning* | 3.02 | 1.15 | 0.06 | **3.77** | 1.12 | 0.11 | **< .01** |

Note: 1: ns means not significant. 2. Significantly higher scores were bold.

Third, the U.S. mathematics teachers more frequently shared and discussed effective teaching practices (*M* = 3.23 vs 2.92), developed teaching materials and activities (*M* = 3.64 vs 2.86), discussed how to assess student learning (*M* = 3.66 vs 3.25), or shared beliefs about

teaching and student learning than their Chinese colleagues ($M$ = 3.77 vs 3.02), $p < .05$, and $ps < .01$, respectively.

In addition, there were no significant differences between Chinese and U.S. mathematics teachers in doing lesson planning ($M$ = 3.97 vs 4.00), discussing how to improve student learning ($M$ = 3.88 vs 3.54), and analyzing student achievement data ($M$ = 3.23 vs 3.25), $ps > .05$.

However, regardless these differences, there were no significant proportional differences for Chinese and U.S. teachers with regard to requirements of using the same or similar curriculum materials (97.1% vs 94.9%), having external assessments for student learning (71.9% vs. 80.6%), and discussing how to improve student learning (94.3% vs 94.9%), discussing how to assess students' mathematics learning (90.4% vs 89.8%), and analyzing student achievement data (94.4% vs 95.9%), $ps > .05$, as Table 4 indicated. Additionally, as shown in Table 5, there were no significant mean differences between Chinese and U.S. mathematics teachers with regard to doing lesson planning ($M$ = 3.97 vs 4.00), discussing how to improve student learning ($M$ = 3.88 vs 3.54), and analyzing student achievement data ($M$ = 3.23 vs 3.25), $ps > .05$.

### Comparisons of Teacher Self-Efficacy, Collective Teacher Efficacy, and Pedagogical Content Knowledge

The descriptive statistical analysis and ANOVA also led to several findings about the differences and similarities between Chinese and U.S. mathematics teachers regarding their self-efficacy and collective teacher efficacy in teaching mathematics. First, in terms of teacher self-efficacy, there was significant difference between Chinese and U.S. mathematics teachers (see Table 6). Chinese teachers rated themselves significantly higher than U.S. teachers on specific self-efficacy in teaching mathematics while U.S. teachers rated themselves significantly higher in general self-efficacy in teaching mathematics than Chinese teachers, $ps < .01$.

Table 6 Means, Standard Deviations, and SD Errors of Three Surveys for Chinese and the U.S. Samples

| Survey | Subscale | Sample | *M* | *SD* | *Std. Error* | *p* |
|---|---|---|---|---|---|---|
| Teacher Self-Efficacy | *Specific self-efficacy* | U.S. Teachers | **2.62** | 1.08 | 0.11 | < .01 |
| | | Chinese Teachers | **3.47** | 0.74 | 0.04 | |
| | *General self-efficacy* | U.S. Teachers | **4.38** | 0.62 | 0.06 | < .01 |
| | | Chinese Teachers | **3.99** | 0.62 | 0.03 | |
| Collective Teacher Efficacy | *Group-competence* | U.S. Teachers | **3.77** | 0.54 | 0.05 | < .05 |
| | | Chinese Teachers | **3.93** | 0.61 | 0.03 | |
| | *Cooperation* | U.S. Teachers | 3.96 | 0.59 | 0.06 | ns |
| | | Chinese Teachers | 3.99 | 0.58 | 0.03 | |
| | *Collaboration and collegiality* | U.S. Teachers | **2.79** | 0.84 | 0.08 | < .01 |
| | | Chinese Teachers | **3.86** | 0.67 | 0.03 | |
| Pedagogical Content Knowledge | *Pedagogical content knowledge* | U.S. Teachers | **1.69** | 0.98 | 0.10 | < .01 |
| | | Chinese Teachers | **1.94** | 0.37 | 0.02 | < .01 |

Table 7 Means and Standard Deviations of Each Item on Teacher Self-Efficacy for Chinese and U.S. Samples

| Subscale | Items | Chinese Sample | | U.S. Sample | |
|---|---|---|---|---|---|
| | | *M* | *SD* | *M* | *SD* |
| Specific Self-Efficacy | Even if I try very hard, I do not teach mathematics as well as I do most subjects. | 3.79 | 1.10 | 2.55 | 1.33 |
| | I am not very effective in monitoring mathematics activities. | 3.19 | 1.04 | 2.72 | 1.21 |
| | I generally teach mathematics ineffectively. | 3.51 | 1.08 | 2.43 | 1.39 |
| | I find it difficult to use manipulatives to explain to students why mathematics works. | 3.37 | 1.16 | 2.83 | 1.20 |
| | Given a choice, I do not invite the principal to evaluate my mathematics teaching. | 3.11 | 1.20 | 2.65 | 1.41 |
| | When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better. | 3.74 | 1.11 | 2.42 | 1.41 |
| | I do not know what to do to turn students on to mathematics. | 3.57 | 1.15 | 2.72 | 1.06 |
| General Self-Efficacy | I know how to teach mathematics concepts effectively. | 3.81 | .87 | 4.03 | .78 |
| | I understand mathematics concepts well enough to be effective in teaching elementary mathematics. | 3.86 | .94 | 4.37 | .79 |
| | I am typically able to answer students' mathematics questions. | 4.20 | .83 | 4.45 | .81 |
| | When teaching mathematics, I usually welcome student questions. | 4.10 | 1.00 | 4.70 | .67 |

Based on Table 7, Chinese teachers reported significantly higher scores on items, such as "I find it difficult to use manipulatives to explain to students why mathematics works", and "I am not very effective in monitoring mathematics activities", *ps* $< .01$ (see Table 7). However, U.S. mathematics teachers rated significantly higher than their Chinese colleagues on items, such as "When teaching mathematics, I usually welcome student questions" and "I am typically able to answer students' mathematics questions", *ps* $< .01$ (see Table 7).

Second, with regard to collective teacher efficacy, there were differences, as well as similarities between Chinese and U.S. mathematics teachers (see Table 6). Results of comparisons between Chinese and U.S. mathematics teachers indicated that Chinese teachers scored significantly higher than their U.S. colleagues in Group-competence, $p < .05$. Such items included, for example, "Teacher in my department are able to get through to difficult students" and "Teachers in my department really believe every child can learn mathematics" (see Table 8). There was also a significant difference between Chinese teachers and their U.S. colleagues in Collaboration and collegiality, $p < .01$. Such items included, for example, "Teachers in my department observe other teachers teaching and provide feedback" (see Table 8). However, no significant difference was found between Chinese and U.S. mathematics teachers in terms of their Cooperation, $p > .05$, for example, "Teachers in my department discuss particular lessons that were not very successful" and "Teachers in my department work together to develop teaching materials or activities for particular classes".

Third, regarding pedagogical content knowledge, overall, the results showed that Chinese mathematics teachers scored significantly higher than their U.S. counterparts, $p < .01$ (see Table 6). Table 9 also presented means and standard deviations of each item on pedagogical content knowledge. These items included teachers' knowledge of the difficulty level of a given problem

for a middle school student, teachers' knowledge of student misunderstanding of a mathematics concept, teachers' knowledge of connecting a current concept with student prior knowledge, and teachers' knowledge of representation and communication of a mathematics concept.

Table 8 Means and Standard Deviations of Each Item on Collective Teacher Efficacy for Chinese and the U.S. Samples

| Subscale | Item | Chinese Sample | | U.S. Sample | |
|---|---|---|---|---|---|
| | | *M* | *SD* | *M* | *SD* |
| Group-Competence | Teachers in my department have what it takes to get the children to learn mathematics. | 4.10 | 0.78 | 3.97 | 0.67 |
| | Teachers in my department are able to get through to difficult students. | 4.02 | 0.80 | 3.59 | 0.76 |
| | Teachers in my department are confident they will be able to motivate their students to learn mathematics. | 4.06 | 0.76 | 3.45 | 0.82 |
| | Teachers in my department really believe every child can learn mathematics. | 3.59 | 1.13 | 3.77 | 0.82 |
| | Teachers in my department are well-prepared to teach mathematics they are assigned to teach. | 3.94 | 0.85 | 4.00 | 0.69 |
| | Teachers in my department are skilled in various methods of teaching. | 3.88 | 0.94 | 3.83 | 0.68 |
| Cooperation | Teachers in my department share their ideas of teaching with other teachers. | 3.92 | 0.90 | 4.14 | 0.77 |
| | Teachers in my department share and discuss student work. | 3.86 | 0.86 | 3.90 | 0.77 |
| | Teachers in my department analyze and discuss student achievement data. | 4.01 | 0.74 | 4.09 | 0.75 |
| | Teachers in my department discuss particular lessons that were not very successful. | 3.77 | 0.90 | 3.95 | 0.80 |
| | Teachers in my department plan curriculum together. | 3.96 | 0.83 | 4.23 | 0.63 |
| | Teachers in my department think they have an obligation to help each other do their best. | 4.12 | 0.71 | 3.75 | 0.97 |
| | Teachers in my department discuss with other teachers what they have learned at workshops or conferences | 4.05 | 0.78 | 4.02 | 0.75 |
| | Teachers in my department feel supported by colleagues in teaching. | 4.14 | 0.73 | 4.04 | 0.81 |
| | Teachers in my department share and discuss effective instructional practices. | 4.09 | 0.79 | 3.99 | 0.88 |
| | Teachers in my department work together to develop teaching materials or activities for particular classes. | 4.05 | 0.80 | 4.09 | 0.89 |
| | Teachers in my department discuss how to help students who have problems in and with learning mathematics. | 4.04 | 0.79 | 3.82 | 0.87 |
| | Teachers in my department feel they are accountable for students' learning. | 4.14 | 0.73 | 3.93 | 0.85 |
| | Teachers in my department share similar beliefs about teaching and learning. | 3.73 | 1.00 | 3.58 | 0.89 |
| Collaboration and Collegiality | Teachers in my department observe other teachers teaching and provide feedback. | **4.00** | 0.83 | **2.41** | 1.14 |
| | Other teachers in my department observe my teaching practice. | **3.93** | 0.83 | **2.51** | 1.17 |
| | Teachers in my department engage in joint activities across different classes. | **3.74** | 1.01 | **3.02** | 1.00 |
| | Teachers in my department think they should hold accountable to each other's mathematical teaching | **3.75** | 0.81 | **3.21** | 0.82 |

Table 9 Means and Standard Deviations of PCK for Chinese and U.S. Samples

| Items | Chinese Sample | | U.S. Sample | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| Understanding of the difficulty level of a problem | 2.45 | 0.98 | 2.11 | 1.32 |
| Student misunderstanding of consecutive natural numbers | 2.83 | 1.08 | 2.28 | 1.65 |
| Connection of a content with student prior knowledge | 1.02 | 0.58 | 0.89 | 0.48 |
| Understanding of student mathematical thinking | 1.81 | 0.58 | 1.59 | 0.87 |
| Representation and communication | 1.37 | 1.07 | 1.60 | 1.44 |

**Relationship between Teacher Self-Efficacy and Collective Teacher Efficacy**

The results of correlational analysis revealed different and similar patterns of the relationships of teacher self-efficacy and collective teacher efficacy for Chinese and U.S. samples. Table 10 presented the results of correlation coefficients between teacher self-efficacy and collective teacher efficacy for the Chinese sample at the lower left triangle and for the U.S. sample at the upper right triangle. First, with regard to the relationship between two subscales of teacher self-efficacy, for Chinese teachers their specific self-efficacy was significantly correlated with their general self-efficacy, $r = .33$, $p < .01$, while there was no significant relationship between specific self-efficacy and general self-efficacy for U.S. teachers, $r = -.064$, $p > .05$.

Table 10 Correlations among Teacher Self-Efficacy, Collective Teacher Efficacy, and Pedagogical Content Knowledge for Chinese (Lower Left Triangle) and U.S. Samples (Upper Right Triangle)

| Indicator | Specific Self-Efficacy | General Self-Efficacy | Group-Competence | Cooperation | Collaboration and Collegiality | PCK |
|---|---|---|---|---|---|---|
| Specific Self-Efficacy | - | -.064 | -.043 | .031 | -.18 | .22* |
| General Self-Efficacy | .33** | - | .19 | .19 | -.30** | .056 |
| Group-Competence | .27** | .40** | - | .63** | .35** | .18 |
| Cooperation | .12* | .32** | .67** | - | .41** | .14 |
| Collaboration and Collegiality | .069 | .27** | .59** | .83** | - | -.19 |
| PCK | .036 | -.069 | -.015 | .045 | .009 | - |

* $p < .05$; ** $p < .01$.

Second, in light of relationships between the three subscales of collective teacher efficacy, for Chinese teachers, their group-competence was significantly correlated with cooperation, $r = .67$, $p < .01$, group-competence was significantly correlated with collaboration and collegiality, $r = .59$, $p < .01$, and cooperation was significantly correlated with collaboration and collegiality, $r = .83$, $p < .01$ (see Table 10 lower left triangle). For the U.S. teachers, their group-competence was significantly correlated with cooperation, $r = .63$, $p < .01$, group-competence was significantly correlated with collaboration and collegiality, $r = .35$, $p < .01$, and cooperation was significantly correlated with collaboration and collegiality, $r = .41$, $p < .01$ (see Table 10 upper right triangle).

Third, regarding the relationship between specific self-efficacy and collective teacher efficacy, for Chinese teachers, their specific self-efficacy was significantly correlated with their group-competence, and cooperation, $r = .27$, $p < .01$, and $r = .12$, $p < .05$, respectively. There was no significant correlation between specific self-efficacy and collaboration and collegiality, $r = .069$, $p > .05$ (see Table 10 lower left triangle). For U.S. teachers, however, there were no significant relationships between specific self-efficacy and group-competence, cooperation, and collaboration and collegiality, *ps* > .05 (see Table 10 upper right triangle).

Fourth, in light of the relationship between general self-efficacy and collective teacher efficacy, for Chinese teachers, their general self-efficacy was significantly correlated with their group-competence, cooperation, and collaboration and collegiality, $r = .40$, $p < .01$; $r = .32$, $p < .05$; and $r = .27$, $p < .01$, respectively. For U.S. teachers, general self-efficacy was found significantly but negatively correlated with collaboration and collegiality, $r = -.30$, $p < .01$, suggesting teachers with higher general self-efficacy tended to report lower collaboration and collegiality. However, there were no significant relationships between general self-efficacy and

group-competence, and general self-efficacy and cooperation, $r = .19$, $ps > .05$, respectively (see Table 10 upper right triangle).

**Relationship between Teacher Efficacy and Pedagogical Content Knowledge**

The results of correlational analysis also revealed different patterns of the relationship between teacher efficacy and pedagogical content knowledge for Chinese and U.S. mathematics teachers (see Table 10). Neither two subscales of teacher self-efficacy nor three subscales of collective teacher efficacy was significantly related to pedagogical content knowledge for Chinese teachers, $ps > .05$. For U.S. teachers, only specific self-efficacy was significantly correlated with pedagogical content knowledge, $r = .22$, $p < .01$. The findings of this study suggested that neither teacher self-efficacy nor collective efficacy was significantly related to pedagogical content knowledge for Chinese teachers. For U.S. teachers, only specific self-efficacy was significantly and positively correlated with pedagogical content knowledge.

# CHAPTER 5 DISCUSSION AND IMPLICATIONS

Chapter 5 briefly summarized the results of the study and discussed the reasons that account for the results, implications for educational research, and limitations of the study. The chapter focused on the discussions of the understandings of the relationships among teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge in individualist and collective teaching contexts, implications of this study, as well as its limitations.

## Mathematics Teaching Contexts in China and the US

The results of this study showed that Chinese and U.S. mathematics teaching contexts were significantly different from each other in several way. First, a larger proportion of Chinese teachers than their U.S. colleagues reported that they were required to plan lessons together, observe teaching, critique the observed lessons and provide feedback to each other. Second, consistent with what mathematics teachers were required to do regarding their daily teaching activities, Chinese teachers reported higher frequencies that they have been observing other teachers' teaching, or having other teachers observe their teaching, and critiquing each other's teaching and providing feedback. In contrast, U.S. mathematics teachers more frequently shared and discussed effective teaching practices, developed teaching materials and activities, or shared beliefs about teaching and student learning. Third, U.S. teachers rated the items of the key features of collectivist teaching contexts with significantly lower scores than Chinese teachers.

The findings of this study were consistent with previous studies on the distinction of cultures of teacher/teaching in China and the US (e.g., Ball, 1994; Little, 1990; Wang, 2001; Wang & Paine, 2003). A. Hargreaves (1994) refers cultures of teacher/teaching to "beliefs, values, habits and assumed ways of doing thing among communities of teachers who have had to deal with similar demands and constrains over many years" (p. 165). The cultures of

teacher/teaching consist of two important dimensions: content and form (A. Hargreaves, 1994). The content of teacher/teaching cultures are teachers' shared beliefs, values, attitudes, and assumptions and ways of doing things within a particular teacher group, or in the wider teaching community, which can be found in and represented by what teachers think, say, and do. The form of teacher/teaching cultures is composed by "the characteristic patterns of relationship and forms of association between members of those cultures" which can be observed in "how relations between teachers and their colleagues are articulated" (A. Hargreaves, 1994, p. 166). The form of teacher/teaching cultures might be individualistic or collectivist, which is constructed mainly by the interactions and relations between teachers and colleagues. As a result, teacher/teaching cultures in China and the US are largely contingent upon the way in which teachers interact with and relate to their colleagues as found in this study, and other relevant organizational factors, such as national curriculum and assessment system.

The curriculum and assessment system in China, for a long time, has been centralized in nature (Eckstein & Harold, 1993; Law, 2014). K-12 schools and teachers are mandated to implement the centralized curriculum and standards unconditionally due to the considerable systematic constrains and the high-stake public examinations of teaching and student learning internally and externally, which largely impact teachers' curriculum decision making (Wang & Paine, 2003; Zhang & Ren, 1998). Indeed, in this type of teaching context teachers across the nation may understand the curriculum better through their professional training in teacher education programs and teaching practices. Accordingly, schools and teachers have limited autonomy to decide to adapt one curriculum over the other although recently the calls for the national curriculum reforms intended to promote such autonomy (Law, 2014; Li & Ni, 2012; Yan, 2015; Yin, 2013). Scholars are concerned that the centralized curriculum and open

examination system and the requirements for teachers to conduct open or demonstration lessons within the Teaching and Research Group or open class to the school administrators or all teachers may harm teachers' autonomy. They argued that such teaching contexts in China may impose pressures to teachers, especially for the novice teachers and that the observation and related critiques may impact new teachers to adopt innovative teaching practice (e.g., Paine, 1997). However, Ting Wang (2015) argued that intentionally arranged organizational structures support teachers' professional learning and collective inquiry, which leads to genuine collegiality and enhances disciplined collaboration and shared responsibility, while contrived collegiality does not. Wang (2015) also commented that the nature of Teaching and Research Group (*jiaoyanzu*) evolved over time, which focuses on more reflection, dialogue, and research than traditional one that emphasizes sharing teaching experiences. In China, as Ryan et al. (2009) and Wang (2015) observed, collaboration among Chinese teachers is characterized by "deliberately arranged, genuine collegiality" (Wang, 2015, p. 918). Teachers in China open their classes for observation, and are more open to peers', especially senior colleagues' or administrators' critique of their teaching. Such open lessons have been recognized to be one of the essential components of teachers' teaching process and a useful professional learning strategy since it holds teacher accountable for their teaching, as well as student learning.

In contrast, teacher/teaching culture in the US has been characterized as teacher individualism, teacher isolation, and teacher privatism (D. Hargreaves, 1993). The U.S. curriculum and assessment system is historically characterized with decentralized education and local control (Cohen & Spilane, 1992; Eckstein & Harold, 1993; D. Hargreaves, 1993, 1994). In this context teachers have more autonomy over both curriculum and instruction. However,

individualism, isolation, and privatism have been challenged when collaboration and collegiality are the image of preferred inspiration of the educational reforms (D. Hargreaves, 1993).

The finding of individualized U.S. teacher/teaching culture was also consistent with the newly released results from TALIS 2013 (OECD, 2015a), which indicated that U.S. lower secondary teachers who taught the seventh, eighth, and ninth grades, tended to work independently. The report suggested “the traditional view of teachers as working in a closed classroom in isolation from colleagues still seems to hold true for many U.S. teachers” (OECD, 2015b, p. 1). Over 50% of these lower secondary teachers reported that they have never taught jointly (co-taught) in the same classroom with a colleague or never observed other teachers and provided feedback on their teaching.

In the US, new initiatives, such as the National Council of Teachers of Mathematics (NCTM, 1991, 2000) standards and Common Core State Standards (CCSS, 2010), were enacted and implemented at different levels; and U.S. teachers, particularly in the areas of mathematics and English and language arts, have been called to collaborate with each other using professional learning community (Louis, Marks, & Kruse, 1996). However, the standards such as CCSS have established what students need to learn rather than how teachers should teach (CCSS, 2015). As a result, teachers still need to develop their own lesson plans and curricula, and design their instruction to accommodate individual students in their classrooms (CCSS, 2015). Although collaboration is commonly recognized as the essential part in implementing standards, as Zhang (2014) observed, teachers, particular new teachers, face challenges in collaboration with teachers in implementing CCSS. The U.S. mathematics teachers in Zhang’s (2014) study reported that they planned lessons together, shared and discuss effective teaching practice, and developed teaching material or activities, and discussed how to assess student learning. Nonetheless,

teachers still lack collaboration in peer observation and peer feedback with meaningful suggestions as well as complimentary feedback.

As a result, the evidence of this current study supported the theoretical assumption, proposed in Chapter 1, and echoed previous studies. Therefore, although China has made efforts to decentralize curriculum and the US has pushed teachers to implement the Common Core State Standards with an emphasis on collaboration more than before, it is still evident that Chinese teaching context remains to be more collectivist-oriented, while U.S. teaching context is still more individualist-oriented. The findings of this study added empirical evidence to knowledge base of mathematics teaching contexts and deepened our understanding of different mathematics teaching contexts in China and the US. The Chinese teaching context is characterized with more frequent activities that teachers plan lessons together, observe teaching, critique the observed lessons, and provide feedback to each other, while U.S. teaching context is characterized with less frequent activities that teachers observe teaching, critique the observed lessons, and provide feedback to each other. Future studies may further develop more measures of mathematics teaching contexts, such as observation of teaching practices and teachers' daily interactions with colleagues. At policy level, educational administrators may want to consider how to develop a collective teaching culture/context, in which teachers' collaboration and collegiality are encouraged and strengthened.

**Teacher Efficacy of Chinese and U.S. Mathematics Teachers**

The findings of this study indicated two apparent findings related to teachers' self-efficacy and collective teacher efficacy. First, Chinese mathematics teachers rated their self-efficacy in teaching mathematics significantly higher than their U.S. colleagues on items that focus on more specific teaching tasks. The findings of this study not only partially confirmed the

results from TALIS 2013 (OECD, 2015a), which revealed that U.S. teachers reported relatively higher levels of confidence in their abilities as teachers, but also further revealed how mathematics teachers reported their teacher efficacy related to the subject.

Although there was no direct comparison of Chinese and U.S. teachers in terms of their self-efficacy in teaching mathematics, Shi's (2014) study provided an insight for the examination of teacher self-efficacy in teaching mathematics in Chinese and U.S. teaching contexts. Drawing on data from TIMSS 2011 mathematics teachers from five Asian countries/regions, Shi (2014) found that mathematics teachers from Korea, Japan, Chinese Taipei, Hong Kong, and Singapore reported significantly lower self-efficacy in teaching mathematics than their international colleagues. Despite no explicit comparison of mainland Chinese and U.S. teachers, Shi (2014) argued that perhaps Asian culture in the five countries/regions shapes teachers' perceptions about their self-efficacy in teaching mathematics, which leads to their lower rating about their ability to teacher mathematics. Lin, Gorrell, and Taylor (2002) also found that Taiwanese preservice teachers in general reported lower efficacy than U.S. preservice teachers, while Taiwanese preservice teachers rated higher than U.S. preservice teachers on some items. They argued that teachers' perceptions of efficacy are "embedded within teaching cultures that may reflect, transmit, and modify the values of society" (p. 44). Klassen et al.'s (2009) study revealed that a pattern of higher scores for Canadian and U.S. samples, and relatively lower scores for Korean and Singaporean teachers on individual items as well as the composite scores of teacher self-efficacy. Other studies also suggested the similar differences in levels of teacher self-efficacy across teachers from Australian and East Asian country/region (Ho & Hau, 2004). These studies collectively suggested the differences in teacher self-efficacy for teachers from Western and East Asian cultures. A recent study by Fackler and Malmberg (2016) indicated that for 13 OECD

countries, variance of teacher self-efficacy was accounted for by teacher characteristics, country-level factors, as well as school differences, and that most of the unexplained variance is between schools. Therefore, future studies in teacher efficacy need to attend to the school context and explore how the school context relates to teacher efficacy.

Other studies also supported the finding that the cultural differences between Eastern and Western countries relate to the different teacher efficacy. Klassen et al. (2009) explored the validity of teacher self-efficacy scale in five countries of Canada, the USA, Cyprus, Korea, and Singapore. They found that strong measurement invariance was found in groups of teachers from similar cultural and geographical regions, such as Canada and the USA in North America, Korea and Singapore in Asia. Strong measurement invariance was found for groups of teachers from Canada and the USA who shared similar languages, cultural dimensions, and school systems, regardless school level, teacher preparation, and teaching environment. Although researchers have not achieved a general consensus on how to best measure the sources of self-efficacy in academic settings (Usher & Pajares, 2009), a commonly accepted idea of the comparison of a psychological construct, as teacher self-efficacy, for the participants from different cultures is to identify a wider range of cultural settings and their functions on human behaviors (Pajares, 1997). This study contributed to the research in teacher efficacy related to mathematic teaching and the findings suggested that the cultural contexts were related to mathematics teachers' self-efficacy. In the collective culture, mathematics teachers such as Chinese teachers were confident in content specific teaching tasks, while in an individualistic society such as the U.S., teachers developed their self-efficacy related to general teaching tasks and student learning.

Second, with regard to collective teacher efficacy, Chinese mathematics teachers rated their "Group-competence" and "Collaboration and collegiality" significantly higher than U.S.

mathematics teachers, while there was no significant difference in "Cooperation" for these two samples. Group-competence, as the "judgments about the capabilities that a faculty brings to a given teaching situation" (Goddard, 2002a, p. 100), consists of inferences about the faculty's teaching methods, skills, training, and expertise. Collaboration and collegiality, based on the framework of TALIS 2013 (OECD, 2013), may involve more sophisticated forms of cooperation, such as collective learning activities, including observing each other's teaching, providing feedback, and team teaching. Therefore, it is appropriate to consider teacher collaboration and collegiality as the higher level of teacher cooperation. As discussed earlier, Chinese teachers are required to observe, evaluate, critique, and provide feedback to colleagues' teaching (Paine, 1997; Paine & Fang, 2006; Paine & Ma, 1993; Wang & Paine, 2003). They also are required to open their teaching to colleagues, senior faculty, and administrators. It is a commonly accepted practice for Chinese teachers to observe and critique colleagues' teaching and listen to the colleagues' critique and feedback. When this type of practice of learning to teach becomes a norm among in-services teachers, it is much easier for them to internalize such administrative demands and to be willing to open the classroom to the colleagues (Ryan et al., 2009). However, D. Hargreaves (1994) argues that this contrived collegiality imposed on teachers may be detrimental to genuine teacher collaboration and collegiality because contrived collegiality is administratively regulated, compulsory, implemented-oriented, fixed in time and space, and unpredictable, which would hinder teachers from collaboration. In his study, Datnow (2011) did not observe the negative effect of contrived collegiality. Rather, he found that many teachers involved in more genuine collaborative activities. I would argue that, according to Ting Wang's (2015) findings from in-depth interviews with 20 participants from Northeast of China, the deliberately arranged organizational structures, including school-based, instructional

collaborative teams, and induction programs and peer mentoring, support teachers' professional learning and collective inquiry because teachers in collaborative teams have shared common goals and responsibility and work interdependently. In China internationally recognized *jiaoyanzu* or collaborative team provides an opportunity for teachers to develop their collective competence and foster collaborative professional learning.

Teacher cooperation and collaboration at the levels of teachers and schools are essential for school improvement (Clement & Vandenberghe, 2000; Datnow, 2011; Rosenholtz, 1989). At the school level, cooperation and collaboration amongst teachers may help to increase overall educational quality and school development by allocating, coordinating, and integrating resources, experiences and strategies of individual teachers together (OECD, 2015a; Zaccaro et al., 1995). At the individual teacher level, cooperation and collaboration allow teachers to not only exchange ideas and practical advice, but also provide opportunities for teachers to grow and support each other, professionally (Clement & Vandenberghe, 2000; OECD, 2013; Rosenholtz, 1989). Therefore, the teaching contexts matter not only to teachers' individual professional development, but also to teachers' collective professional growth, collectively. While the results from OECD reports (OECD, 2013, 2015a) sound reasonable theoretically, the U.S. cultural context and educational system challenges teachers at individual and school levels of teaching practices and collaboration.

This study indicated the connections between teaching context and teacher efficacy, which raised the questions for future study and also had implications for school administration and practice. The individualist teaching culture in the US may challenge teacher cooperation, collaboration and collegiality among mathematics teachers. There is still an ample room for administrators and researchers to explore effective ways to encourage and strengthen teacher

self-efficacy, as well as teacher collaboration and collegiality, through context-based teacher professional development activities and teachers' daily work within and across the department. In addition, it is important for comparative study to incorporate cultural and school contexts into studies of teacher cooperation and collaboration, in which teaching and learning to teach occurs.

**Chinese and U.S. Mathematics Teachers' Pedagogical Content Knowledge**

This current study indicated that Chinese mathematics teachers reported to have developed significantly more pedagogical content knowledge than their U.S. counterparts. The findings echoed earlier studies (An, Kulm, & Wu, 2004; Ma, 1999; Stigler & Hiebert, 1999; Stigler, Lee, & Stevenson, 1986; Zhou, Peverly, & Xin, 2006), which revealed the significant differences between Chinese and U.S. elementary and secondary mathematics teachers' pedagogical content knowledge (An, Kulm, & Wu, 2004).

During the past several decades, especially with the popularity of international studies on mathematics and science, much attention has been given to high-performing Asian countries/regions, such as Singapore, Chinese Taipei, Japan, and Hong Kong, and western countries, including the US. The U.S. students do not perform so well as their international counterparts in mathematics in TIMSS (Mullis et al., 2004, 2008, 2012) and PISA (OECD, 2009, 2010, 2013, 2014). Along with other factors, teachers and teaching are recognized as the most important factors related to student performance in TIMSS and other international studies. According to the National Council of Teachers of Mathematics (NCTM, 2000), "Effective teaching requires knowing and understanding mathematics, students as learners, and pedagogical strategies" (p. 17). Therefore, teachers' pedagogical content knowledge for mathematical teaching becomes the focus of comparative studies.

The findings of this study regarding the significant difference in PCK for mathematics teachers in China and the US were unsurprisingly consistent with what has been identified by the researchers (e.g., An, Kulm, & Wu, 2004; Ma, 1999; Zhou, Peverly, & Xin, 2006). As an important work of such comparison, Ma's (1999) study indicated that Chinese teachers had a more significantly profound understanding of teachers' knowledge of mathematics (SMK) in subtraction with regrouping, multi-digit multiplication, division by fractions, and the relationship between perimeter and area than their American counterparts. Similarly, Zhou, Peverly, and Xin (2006) found that Chinese teachers scored significantly higher than their US colleagues in SMK (concepts, computations, and word problems) and in some areas of PCK (e.g., such as identifying important points of teaching the fraction concepts and how to ensure students' understanding). Drawing on data from 28 U.S. fifth- to eighth-grade mathematics teachers and 33 Chinese fifth- to sixth-grade mathematics teachers, An, Kulm, and Wu (2004) examined Chinese and U.S. teachers' pedagogical content knowledge in the areas of fraction, ratio, and proportion. Although these studies were conducted with different participants at elementary or middle school levels, similar results were revealed that American mathematics teachers lag behind their counterparts with regard to their mathematics pedagogical content knowledge.

Consistent with these studies, the evidence from the current study suggested that Chinese mathematics teachers' pedagogical content knowledge was significantly higher than the U.S. counterparts. The findings might be attributed to the fundamental differences of teacher preparations and mathematics curricula, as well as examination systems in China and the U.S.

***Teacher Preparation in China and the US***

Pedagogy and subject matter are the two components that differ in the teacher education programs in China and the US. Comparing two four-year elementary teacher education programs

for math teacher candidates hosted in a public university in China and the US, Liu and Qi (2006) identified several differences in the two programs, such as program admission standards and requirements, general education courses, education foundation and pedagogy requirements, major subject matter requirements and field experience, and exit program evaluation or examinations. Among these differences, curriculum and pedagogy were found to be substantially differentiated, in addition to subject matter. Teacher education programs in China require less curriculum and pedagogy and more subject matter than its U.S. counterpart, in this case were 12 units and 39 units for curriculum and pedagogy, and 73 units and 12 units, respectively. Chinese teacher education programs emphasize subject matter, which might prepare prospective teachers better for their future instruction in terms of their subject content knowledge (Ma, 1999).

Additionally, another difference between Chinese and U.S. teacher education programs is where the program is housed, which largely determines how preservice teachers are prepared in terms of their subject matter knowledge and pedagogical content knowledge. Over the past decades, teacher education programs in China have experienced a series of top-down reforms (Shi & Englert, 2008; Zhou, 2014). Traditionally, preservice teachers in China are prepared in a discipline department, such as in Department of Mathematics, in which preservice teachers spend more time learning subject matter content knowledge than pedagogy and only several pedagogy courses are required including psychology (combination of educational psychology and developmental psychology), pedagogy, and general teaching methodology (Li, 2012). Only in recent years, models of teacher education programs have shifted from the traditional ones to more diverse models created by universities and colleges (Shi & Englert, 2008; Zhou, 2014). These models represent transformation and amalgamation of preparing and training teachers responded to the social and economic changes in China (Shi & Englert, 2008), as well as the

international community of economy and education (Zhou, 2014). The new models involve the model of “three plus one”, “two plus one plus one”, “two plus two”, and “four plus X” (Shi & Englert, 2008), among them, the first three are for the preparation of undergraduate students, while the last one is for a Master of Arts in Education program, which is similar to the Alternative Route to Licensure (ARL) program in the US. Those models are becoming popular in some large teacher education institutions, such as Beijing Normal University, East China University, and Central China Normal University, to name a few.

On the contrary, teacher education programs in the US have been historically housed in College/School of Education in universities or colleges as a virtual monopoly for a relatively brief period of time from 1960-1990 (Zeichner, 2014). Since the 1990s, the increasing number of non-college and university-based teacher education programs have been emerged (Baines, 2010), with other alternative ways of teacher preparation, such as professional development schools, Teach for America (TFA), Troops to Teachers (TtT), and other alternative routes to prepare future teachers. Upgrading from normal colleges and merged into comprehensive universities, the university-based teacher education programs still play the major role in teacher preparation. Approximately, about 70-80% of teachers enter the teaching profession through college- and university-based programs (National Research Council, 2010).

College- and university-based teacher education programs, as well as non-university sponsored teacher education programs, have placed more emphases on preservice teachers’ pedagogical training and teaching skills development over subject matter content. Therefore, prospective teachers learn more pedagogy and know more about students in general than the subject matter and how to teach a certain concept to students, as documented by scholars and researchers (e.g., An, Kulm, & Wu, 2004; Ma, 1999; Zhou, Peverly, & Xin, 2006). Some argued

that in some situations preservice teachers are not well-prepared before assuming the full teaching responsibility (Grossman & Loeb, 2010; Schmidt et al., 2007) in terms of their instructional knowledge.

The aforementioned factors might account for the difference of pedagogical content knowledge between Chinese and U.S. mathematics teachers. However, more studies are needed to closely examine the difference and potential reasons in order to deepen the understanding with his regard. Through comparing and contrasting mathematics teacher preparation in China and the U.S., it might be reasonable to suggest that both mathematics teacher preparation programs may need to consider balancing the subject content knowledge preparation, as well as pedagogical preparation. The findings of this study have implications for mathematics teacher education programs at practical level. Therefore, secondary preservice teacher programs in China may focus on enhancing preservice teachers' understanding of students and student learning, learning process, differentiated instruction/pedagogy, as observed by Zhou, Peverly, and Xin (2006), while secondary preservice teacher programs in the US may need to direct preservice teaches to take more content related courses to strengthen their understanding of subject content knowledge. As a result, more studies are needed to address such concerns and evaluate the effectiveness of varied teacher education programs.

### ***Different Curricula and Assessment Systems***

In China, teachers adopt textbooks with similar standards since 1980 although currently the textbooks are revised and published more based on each province's local educational administration (Law, 2014; Yin, 2013). The curriculum policy allows students to take the national college entrance tests at the same content level. Due to the testing system, teacher knowledge and students' knowledge are emphasized in education.

Education in China has been criticized for ignoring students' critical thinking and creativity although they are good at taking tests and demonstrate their understanding of knowledge (Cai, 2000; Zhou, Peverly, & Xin, 2006). It is important that Chinese teachers challenge themselves to allow students to learn to apply mathematics to the world so that the classroom teaching is not solely knowledge based. The curriculum should also emphasize more activities that enhance students' creativity through solving math problems. The curriculum design and development should appropriately consider the individual learners' needs and teachers' teaching time to implement the curriculum at each grade level.

In the US teacher autonomy and local control policy play an important role in the curriculum implementation (Archbald & Porter, 1994). Together with the influence of individualism of teaching culture, teachers integrate democracy into teaching and learning so that they pay more attention to hands-on activities and linking the teaching and learning to students' individual interests and well-around development. This reality might result in a lot of class time for students to do more activities so that it is difficult for teachers to take more class time to deal with the width and depth of the content as teachers in other Asian countries can do. Although PCK has been valued since the 1980's (Shulman, 1986), the foundations of education as mentioned earlier do not dramatically change teachers' PCK within the short time frame.

In the US there may be a need to consider the balance of knowledge and activities in mathematics teaching. It is important that teachers recognize how activities take class time and to balance the activity time and instruction time so that activity does not conflict the required content for each lesson, unit, or semester. In the recent years the education reform has pushed teachers to teach a deeper level of content but the PCK must be enhanced when the content is changed through effective professional development or teacher education programs.

### Relationship between Teacher Self-Efficacy and Collective Teacher Efficacy

This study found different relationship patterns between teacher self-efficacy and collective teacher efficacy for Chinese and U.S. mathematics teachers. For Chinese teachers, their self-efficacy in teaching mathematics was significantly and positively related to their group-competence, cooperation, and collaboration and collegiality. For U.S. teachers, interestingly, their general self-efficacy in teaching mathematics was only significantly but negatively related to their collaboration and collegiality. This finding suggested that when U.S. teachers maintain higher general self-efficacy in teaching mathematics, they may lack collaboration and collegiality, represented by less likely observing colleagues' teaching, critiquing and providing feedback although they may cooperate with other colleagues.

The finding of relationship between teacher self-efficacy and collective teacher efficacy was consistent with earlier studies (Chan, 2008; Goddard & Goddard, 2001; Kurz & Knight, 2004; Skaalvik & Skaalvik; 2007). Along with these studies this study confirmed that collective teacher efficacy and teacher self-efficacy are somewhat independent constructs but they are moderately and positively related to each other only for Chinese mathematics teachers while this relationship did not exist among the U.S. mathematics teachers. The findings of this study partially supported Hypothesis 2, which stated that there is a moderate to a strong relationship between teacher self-efficacy and collective teacher efficacy in the collectivist teaching context, whereas there is a weak relationship between teacher self-efficacy and collective teacher efficacy in the individualistic teaching context. As Bandura (1997) suggested, teacher efficacy beliefs are dependent upon situational specificity; i.e., efficacy beliefs are determined by the situation or context relevant to the action or task. However, the extent of the relationship between teacher self-efficacy and collective teacher efficacy may vary in different teaching contexts. One

possible reason for the negative relationship for the U.S. teachers might be because only a small portion of U.S. mathematics teachers in this study reported they have done some key collaborative activities in their daily teaching practices, including observing each other's teaching (21.4%) and critiquing each other's teaching and providing feedback (11.2%). The U.S. teachers also scored significantly lower than their Chinese counterparts on the items of "observe other's teaching practices" (1.66 vs. 3.53), "other teachers observe your teaching" (2.33 vs. 3.25), and "critique each other's teaching and provide feedback" (1.63 vs. 3.36). These items are also the key features of teacher collaboration and collegiality. Therefore, although they may feel confident in their abilities as teachers (teacher self-efficacy) and involve in basic forms of co-operation, they rarely participated in higher levels of teacher collaboration (OECD, 2015b). The findings of this study was also supported by the similar results from the recent US TALIS 2013 assessment, which reported that more than 50% of U.S. lower secondary school teachers never teach jointly as a team in the same class, and never observe other teachers' class and provide feedback (OECD, 2015b).

According to TALIS 2013 (OECD, 2015a), conceptually, teacher cooperative behaviors can be categorized into two broad groups: one group refers to the behaviors that demonstrate teacher exchange and coordination; the other group refers to the behaviors that demonstrate professional collaboration between teachers. Teacher co-operation refers to teachers' collaboration to achieve common goals of their daily work, such as exchanging and developing materials or new pedagogical practices, preparing lesson together or do team teaching. This cooperation has been found to support teachers to collaborate with each other (OECD, 2015a). The first category of teacher exchange and coordination comprises the exchange of instructional material between teachers and can include regular meetings for discussions about students,

teaching strategies and subject matter. The second category, teacher professional development, involves more sophisticated forms of cooperation that include collective learning activities like observing others, providing feedback, and teaching jointly as a team. From this perspective, we might see U.S. mathematics teachers have cooperation more than collaboration in their daily work than their Chinese colleagues. Therefore, it is reasonable to argue that effective teaching not only needs teachers' cooperation but also needs teachers' collaboration.

To conclude, the relationship between teacher self-efficacy and collective teacher efficacy is situated in the contexts in which teachers work individually as well as collectively. However, the extent to which teachers collaborate each other also differ from context to context. In a more collectivist-oriented teaching context, teachers collaborate not only in their daily teaching routines, such as exchanging teaching materials, but also observe each other's teaching and provide feedback to colleagues' teaching. Teacher self-efficacy and collective teacher efficacy in this teaching context may closely relate to each other. Whereas in a more individualist-oriented teaching context, teachers collaborate more in their daily teaching rather than open their classes to their colleagues, and provide feedback to their colleagues' teaching. Teacher self-efficacy and collective teacher efficacy in this teaching context may loosely relate to each other. The findings of this study supported the hypothesized models of relationship between teacher self-efficacy and collective teacher efficacy in Chinese and U.S. teaching contexts, as demonstrated in Figure 3. This finding of this study also challenged the popular assumption of the positive relationship between teacher self-efficacy and collective teacher efficacy in the US, as suggested by Wheatley (2002), teacher efficacy doubts may have potential benefits for educational reform. As a result, it seems possible that too lower as well as too higher self-efficacy may not necessarily lead to positive results as assumed. Therefore, theoretically, the

relationship of teacher self-efficacy and collective teacher efficacy needs to be revisited seriously.

**Relationship between Teacher Efficacy and Pedagogical Content Knowledge**

Focusing on middle school mathematics teachers' pedagogical content knowledge and self-efficacy, as well as collective teacher efficacy, this current study indicated that there is no significant relationship between teacher self-efficacy or collective teacher efficacy with teachers' pedagogical content knowledge for Chinese mathematics teachers, while only teacher specific self-efficacy was significantly related to pedagogical content knowledge for U.S. mathematics teachers. The findings were surprising since the published studies demonstrated the connection between knowledge and efficacy. For example, drawing on data from 120 preservice and 102 in-service teachers, Fives (2003b) found that preservice teachers' demonstrated knowledge was not related to their efficacy but performance, while experienced teachers' demonstrated knowledge was associated with efficacy but not performance. However, the relationship between demonstrated knowledge and teacher efficacy was negative in nature, indicating that teachers with a higher sense of self-efficacy tended to demonstrate less knowledge. The different patterns of the relationship between teacher self-efficacy and demonstrated knowledge for preservice teachers and in-service teachers were identified, which suggests different development trajectories of different teachers through the course of instructional practice (Lannin et al., 2013). Similarly, McCoy (2011) found that neither dimension of mathematics teacher efficacy (named personal mathematics teacher efficacy and mathematics teaching outcome expectancy) significantly predicted the growth of specialized mathematics content knowledge for 101 preservice elementary teachers in the US. As discussed earlier, mathematics teachers in China and the US developed their pedagogical content knowledge through different routes, including

the emphases of different teacher preparation programs, different curriculum and assessment systems, and most importantly different teaching/teacher contexts and professional learning communities, in which mathematics teachers learn to teach and grow professionally. In addition, Swars et al. (2007) found that preservice teachers' pedagogical beliefs and teaching efficacy beliefs were not related to each other at the beginning of the program, but their pedagogical beliefs were positively correlated to their specialized content knowledge for teaching mathematics at the end of the program.

The relationship of pedagogical content knowledge in conjunction with teacher self-efficacy and collective teacher efficacy has not been addressed in the literature (Fives, 2003a). In the research of relationship between mathematics teachers' efficacy and mathematical knowledge with K-12 teachers, few studies offered evidence for the existing positive relationship between preservice teachers' science knowledge and self-efficacy (Schoon & Boone, 1998), and English teachers' knowledge and self-efficacy (Zakeri & Alavi, 2011). However, this was not always the case for the study that found no significant relationship existed between preservice teachers' actual knowledge of phonemic awareness and self-efficacy for teaching phonemic awareness (Martinussen, Ferrarim, Aitken, & Willows, 2015). As a result, the limited published empirical studies may not help achieve a common understanding of the relationship.

This study did not identify the significant relationships between teacher self-efficacy, collective teacher efficacy, and pedagogical content knowledge for Chinese mathematics teachers. It only found the positive relationship between specific teacher self-efficacy and pedagogical content knowledge for U.S. mathematics teachers. The findings of this study revealed non-significant relationship between teacher efficacy and one of the most important components of mathematics teaching practices—teachers' pedagogical content knowledge,

which raised the question pertaining to the popular practices in teacher education programs in which enhancing preservice or in-service teachers efficacy is the goal, in turn, enhancement of teacher efficacy may lead to higher teaching performance, and possible higher student performance. There might be other factors existed between teacher efficacy and teaching practices, such as teachers' effort and perseverance, as suggested by researchers (e.g., Goddard et al., 2004; Tschannen-Moran et al, 1998), play an important role in between. This assumption should be tested in future research by operationalizing efforts and perseverance in actual classroom setting.

One of the possible reasons of non-significant relationship between teacher efficacy and pedagogical content knowledge might relate to the measurement of pedagogical content knowledge. This study adopted the released pedagogical content knowledge items developed by the Teacher Education and Development Study in Mathematics (TEDS-M). Items were excluded in the analysis due to their low loading on the respondent factors. Therefore, the limited items used for the analysis may prevent from capturing a whole picture of teachers' pedagogical content knowledge, which itself is relatively complicated and difficult to measure. Future studies need to incorporate classroom observations, interviews, reflective journals, or other methods into the measurement of PCK and triangulate these data sources with survey measurement (Shechtman, Roschelle, Haertel, & Knudsen, 2010; Wyatt, 2014). Since Shulman coined the terms of pedagogical content knowledge, the concept of PCK itself has been developed and extended with more components added, from Shulman's PCK (1986) to mathematical knowledge for teaching for elementary mathematics teachers (Ball, Thames, & Phelps, 2008), to Tatto and colleagues' (2008) knowledge for planning for mathematics teaching and learning and knowledge for enacting mathematics for teaching and learning for secondary mathematics

teachers. The development of the concept of PCK provides the opportunity and challenges for researchers and scholars to examine the concept through different lens but it also results in methodologically measuring PCK differently.

Methodologically, the findings of this study inspired researchers and scholars to further develop and refine the measurements of pedagogical content knowledge, as well as teacher efficacy, and call for a host of methodological approaches to assess PCK and teacher efficacy using quantitative, qualitative, or mixed methods. More and more researchers realize that the quantitative method itself may not be able to ensure capturing the whole profile of PCK and teacher efficacy (e.g., Klassen et al., 2011), and qualitative method in the research of teacher efficacy just starts unfolding (Nurlu, 2015). Future studies may consider employing both qualitative and quantitative methods to deepen our understanding of teachers' pedagogical content knowledge and its relationship with teacher self-efficacy and collective teacher efficacy.

**Conclusions**

Drawing on data from 384 Chinese and 98 U.S. middle school mathematics teachers, this study examined mathematics teaching/teacher cultures in China and the US and the interrelationships among teacher self-efficacy, collective teacher efficacy, and teachers' pedagogical content knowledge, which has not been exclusively examined in the field of teacher education and mathematics education. This study not only identified the similarities and differences between Chinese and U.S. mathematics teachers regarding their self-efficacy in teaching mathematics, collective teacher efficacy, and pedagogical content knowledge, but also shed light on understanding of teaching/teacher cultures in China and the US. Although China and the US have experienced waves of education reforms in teacher education and mathematics education (e.g., NCTM, 1991, 2010; Xie, 2009), the teaching/teacher cultures in China and the

US remained relatively stable or less changed. Teacher/teaching context in China is collectivist-oriented teaching/teacher culture, while the U.S. teachers continues enjoying more individualist-oriented teaching/teacher culture in the US. These teaching/teacher cultures have fundamentally shaped and impacted teachers' instructional practice and teacher interactions and collaboration, as well as teacher development in both countries, as observed by researchers and scholars (Paine & Ma, 1993; Wang & Paine, 2003; Zhang, Shi, & Hao, 2009). This study suggests that any studies pertaining to cross-nation comparisons of instructional practice and teacher development have to take the teaching/teacher cultures and contexts into account, in which teachers learn to teach and develop their professional knowledge about teaching and students learning. This study contributes to the understanding the teaching/teacher culture in China and the US with this regard.

For many decades, teacher self-efficacy and collective teacher efficacy are topical issues in educational psychology and teacher education in the western literature. However, the examination of teacher efficacy in China only has a relatively short history, especially collective teacher efficacy (He & Miao, 2006; Yu, Xin, & Shen, 1995), and comparative studies of Chinese and U.S. teachers' self-efficacy, collective teacher efficacy, especially subject-specified teacher efficacy comparisons, are still insufficient. This study contributes the knowledge base by adding empirical evidence of comparing Chinese and U.S. teacher efficacy. It also identified that Chinese teachers' higher instruction-specified self-efficacy and lower general self-efficacy in teaching mathematics than their U.S. colleagues, which may relate to cultural or teaching context-relevance of items and survey used to measure teacher efficacy in this study. Cross-cultural validation of Teachers' Sense of Efficacy Scale has demonstrated that teacher efficacy is not only closely related to specific contexts, such as subject matter, teaching task, and school

environment (e.g., Ashton & Webb, 1986; Hoy & Woolfolk, 1993; Lee, Dedick, & Smith, 1991), but also is culturally situated and socially constructed (Klassen et al., 2009; Kleinsasser, 2014; Ruan et al., 2015). Future studies may further refine the measurements developed by the western researchers and translated by non-western researchers and adopted to non-western participants, and make the measurement more relevant to the Chinese teaching context.

This study found both similarities and differences between Chinese and U.S. mathematics teachers' collective teacher efficacy in teaching, which suggests that Chinese and U.S. mathematics teachers share similar patterns of cooperation in their daily teaching. For example, they share and discuss student works, plan lessons together with meaningful support for each other. However, the extent and depth of such collaboration and collegiality differ between these two groups, and this difference may result from both organizational and cultural factors. Chinese mathematics teachers reported to observe each other's teaching and provide feedback, while only a small portion of U.S. mathematics teachers do so. Chinese teachers would open the classroom to colleagues and administrators to learn to teach; evidently, this teacher and teaching culture contradicts with the U.S. individualism teaching culture. Although recent education reforms such as CCSS have called for more teacher collaboration toward that direction, the teaching context is still individualism-oriented. Therefore, there is an ample room for the detailed in-depth inquiry to refresh our understanding about how the teaching/teacher cultures and contexts relate to teachers' collective efficacy.

This study contributes to the knowledge base of understandings of the relationships between teacher self-efficacy and collective self-efficacy and between two types of teacher efficacy and teachers' pedagogical content knowledge in individualist and collectivist teaching contexts in several ways. First, it helps researchers better understand the nature and

characteristics of two types of teacher efficacy and their relationships with empirical evidence and helps resolve the conceptual ambiguity. Second, it extends researchers' understanding of the characteristics and functions of teacher efficacy in relating mathematics teachers' pedagogical content knowledge in individualist and collectivist teaching contexts. Third, it enhances the empirical knowledge base for teacher educators and professional development to include teacher efficacy and teacher knowledge components as they develop appropriate curricula and programs that help both preservice and in-service teachers to effectively teach mathematics for student learning. Finally, by providing empirical evidence and theoretical guidance, this study may inspire teacher education program administrators and policy makers to reconsider how to build a collective professional learning community to help preservice and in-service teachers develop appropriate teaching efficacy and pedagogical content knowledge to teach mathematics effectively, and ultimately to enhance students' mathematical learning.

# Appendixes

## Appendix I U.S. Mathematics Teacher Survey

Dear Mathematics Teachers:

I am a doctoral candidate at the Department of Teaching & Learning, University of Nevada, Las Vegas. I am sending you this invitation as a request to participate in my study that investigates secondary mathematics teachers' pedagogical content knowledge. I believe that your participation will not only help me complete my dissertation but will also help you reflect on your mathematics teaching and consequently improve your students' mathematics achievements.

To participate with this study, you are asked to fill out a short teacher-based questionnaire. It will only require about 20-30 minutes to complete. The questionnaire addresses collaboration with colleagues through collective teaching activities. It includes perceptions about your efficacy regarding teaching mathematics at your school. It seeks to explore how teachers at your school/department collaborate as a group, to teach mathematics, and how you help your students learn mathematics.

Time is a matter of some importance regarding this study so you are requested to review and complete the questionnaire at your earliest convenience. It is only through your participation and generous support that this research on mathematics education can be successful. I sincerely thank you for your participation.

Sincerely,

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Part 1 Background Information and School Teaching Context

1. I consent to take part in the study described above.
2. What is your gender? Male ( ); Female ( )
3. How long have you been working as a mathematics teacher?
   Less than 1 year ( ); 1-2 years ( ); 3-5 years ( ); 6-10 years ( ); more than 10 years ( )
4. How long have you been working at the current school?
   Less than 1 year ( ); 1-2 years ( ); 3-5 years ( ); 6-10 years ( ); more than 10 years ( )
5. What was your academic training?
   Mathematics ( ); mathematics education ( ); elementary education ( ); secondary education ( ); Others ( )
6. What is the highest level of formal education that you have completed?
   Associate degree ( ); Bachelor ( ); Master ( ); Doctoral degree ( )
7. Which grade you are teaching? 6th ( ); 7th ( ); 8th ( ); 9th ( )
8. What is the name of your school where you teach? ______________________
9. How many mathematics teachers work at your school?
   ( ) mathematics teachers
10. How many mathematics teachers are in your department?
    ( ) mathematics teachers
11. Does your school require you and your colleagues to use the same or similar curriculum materials?
    Yes ( ); No ( )
12. Does your school have external assessments for students' mathematical learning at unit or semester?
    Yes ( ); No ( )
13. Does the school require you and your colleagues to discuss how to improve mathematics teaching?
    Yes ( ); No ( )
14. Does the school require you and your colleagues regularly to discuss how to improve students' mathematics learning?
    Yes ( ); No ( )
15. Does the school require you and your colleagues to plan lessons together?
    Yes ( ); No ( )
16. Does the school require you and your colleagues to observe each other's teaching?
    Yes ( ); No ( )
17. Does the school require you and your colleagues to critique each other's teaching and provide feedback?
    Yes ( ); No ( )
18. Does the school require you and your colleagues to discuss how to assess students' mathematics learning?
    Yes ( ); No ( )
19. Does the school require you and your colleagues to analyze student achievement data?
    Yes ( ); No ( )
20. How often do you and your colleagues do lesson planning?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )

21. How often do you observe other mathematics teachers' teaching practices?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
22. How often do you and your colleagues share and discuss effective instructional practices?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
23. How often do other mathematics teachers observe your teaching practices?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
24. How often discuss improve learning
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
25. How often do you and your colleagues work together to develop teaching materials or activities for teaching
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
26. How often do you and your colleagues critique each other's teaching and provide feedback?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
27. How often do you and your colleagues discuss how to assess students' mathematics learning?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
28. How often do you and your colleagues analyze student achievement data?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )
29. How often do you and your colleagues share beliefs about teaching and students' learning?
    Never ( ); Once a semester ( ); Once a month ( ); Once a week ( ); More than once a week ( )

Part 2 Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

Directions: Please read each statement carefully. For the statements below, please indicate degree to which you agree or disagree by clicking the appropriate option on a scale of **1 strongly disagree**, to **5 strongly agree**.

| **Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate numbers to the left of each statement.** | **Strongly Disagree** | **Disagree** | **Uncertain** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| 1. Even if I try very hard, I do not teach mathematics as well as I do most subjects. | 1 | 2 | 3 | 4 | 5 |
| 2. I know how to teach mathematics concepts effectively. | 1 | 2 | 3 | 4 | 5 |
| 3. I am not very effective in monitoring mathematics activities. | 1 | 2 | 3 | 4 | 5 |
| 4. I generally teach mathematics ineffectively. | 1 | 2 | 3 | 4 | 5 |
| 5. I understand mathematics concepts well enough to be effective in teaching elementary mathematics. | 1 | 2 | 3 | 4 | 5 |
| 6. I find it difficult to use manipulatives to explain to students why mathematics works. | 1 | 2 | 3 | 4 | 5 |
| 7. I am typically able to answer students' mathematics questions. | 1 | 2 | 3 | 4 | 5 |
| 8. Given a choice, I do not invite the principal to evaluate my mathematics teaching. | 1 | 2 | 3 | 4 | 5 |
| 9. When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better. | 1 | 2 | 3 | 4 | 5 |
| 10. When teaching mathematics, I usually welcome student questions. | 1 | 2 | 3 | 4 | 5 |
| 11. I do not know what to do to turn students on to mathematics. | 1 | 2 | 3 | 4 | 5 |

Part 3 Collective Teacher Efficacy

Directions: This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. Please indicate your opinion about each of the statements below in a scale of 1: nothing, to 5 a great deal. Your answers are confidential.

| Items | **Strongly Disagree** | **Disagree** | **Uncertain** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| 1. Teachers in my department have what it takes to get the children to learn. | 1 | 2 | 3 | 4 | 5 |
| 2. Teachers in my department are able to get through to difficult students. | 1 | 2 | 3 | 4 | 5 |
| 3. Teachers in my department are confident they will be able to motivate their students. | 1 | 2 | 3 | 4 | 5 |
| 4. Teachers in my department really believe every child can learn. | 1 | 2 | 3 | 4 | 5 |
| 5. Teachers in my department are well-prepared to teach mathematics they are assigned to teach. | 1 | 2 | 3 | 4 | 5 |
| 6. Teachers in my department are skilled in various methods of teaching. | 1 | 2 | 3 | 4 | 5 |
| 7. Teachers in my department share their ideas of teaching with others. | 1 | 2 | 3 | 4 | 5 |
| 8. Teachers in my department observe other teacher teaching and provide feedback. | 1 | 2 | 3 | 4 | 5 |
| 9. Teachers in my department are observed by other teachers. | 1 | 2 | 3 | 4 | 5 |
| 10. Teachers in my department share and discuss student work. | 1 | 2 | 3 | 4 | 5 |
| 11. Teachers in my department analyze and discuss student achievement data. | 1 | 2 | 3 | 4 | 5 |
| 12. Teachers in my department discuss particular lessons that were not very successful. | 1 | 2 | 3 | 4 | 5 |
| 13. Teachers in my department plan curriculum with each other. | 1 | 2 | 3 | 4 | 5 |
| 14. Teachers in my department engage in joint activities across different classes. | 1 | 2 | 3 | 4 | 5 |
| 15. Teachers in my department feel responsible to help each other do their best. | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 16. Teachers in my department discuss with others what they have learned at workshop or conference. | 1 | 2 | 3 | 4 | 5 |
| 17. Teachers in my department feel supported by colleagues in teaching. | 1 | 2 | 3 | 4 | 5 |
| 18. Teachers in my department share and discuss effective instructional practices. | 1 | 2 | 3 | 4 | 5 |
| 19. Teachers in my department work together to develop teaching materials or activities for particular classes. | 1 | 2 | 3 | 4 | 5 |
| 20. Teachers in my department discuss how to help students who have problems of learning math. | 1 | 2 | 3 | 4 | 5 |
| 21. Teachers in my department feel they hold accountable for students' learning. | | | | | |
| 22. Teachers in my department feel they hold accountable to each other. | 1 | 2 | 3 | 4 | 5 |
| 23. Teachers in my department share similar beliefs about teaching and learning. | 1 | 2 | 3 | 4 | 5 |

Part 4 Teaching Mathematics

Direction: Please read each question carefully as they are not all worded in the same way. For the following questions, you are asked to answer each question. Some questions ask you to write down your answers.

The following problem appears in a mathematics textbook for lower secondary school.
1. Peter, David, and James play a game with marbles. They have 198 marbles altogether. Peter has 6 times as many marbles as David, and James has 2 times as many marbles as David. How many marbles does each boy have?

2. Three children Wendy, Joyce and Gabriela have 198 zeds altogether. Wendy has 6 times as many zeds as Joyce, and 3 times as much as Gabriela. How many zeds does each child have?

(a) Solve each problem.
Solution to Problem 1:

Solution to Problem 2:

(b) Typically Problem 2 is more difficult than Problem 1 for lower secondary students. Give one reason that might account for the difference in difficulty level.

3. Some lower secondary school students were asked to prove the following statement:
When you multiply 3 consecutive natural numbers, the product is a multiple of 6.

Below are three responses.

**[Kate's] answer**

A multiple of 6 must have factors of 3 and 2.
If you have three consecutive numbers, one will be a multiple of 3.

Also, at least one number will be even and all even numbers are multiples of 2.

If you multiply the three consecutive numbers together the answer must have at least one factor of 3 and one factor of 2.

**[Leon's] answer**

**[Maria's] answer**

$n$ is any whole number

$$n \times (n+1) \times (n+2) = (n^2+n) \times (n+2)$$

$$= n^3 + n^2 + 2n^2 + 2n$$

Canceling the $n$'s gives $1 + 1 + 2 + 2 = 6$

Determine whether each proof is valid.

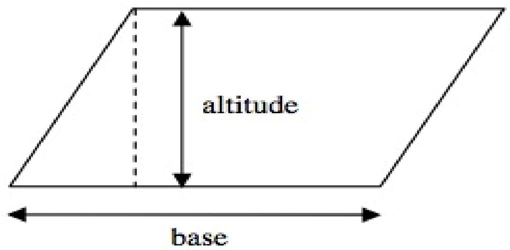
*Check one box in each row.*

| | | Valid | Not valid |
|---|---|---|---|
| A. | [Kate's] proof | ☐ 1 | ☐ 2 |
| B. | [Leon's] proof | ☐ 1 | ☐ 2 |
| C. | [Maria's] proof | ☐ 1 | ☐ 2 |

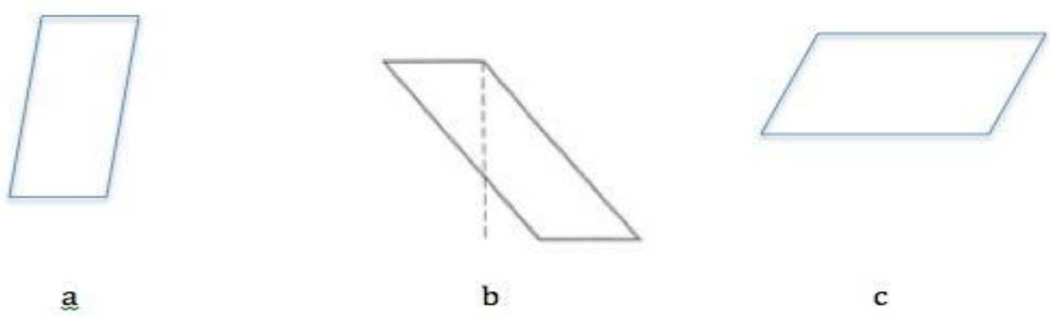
4. A mathematics teacher wants to show some students how to prove the quadratic formula. Determine whether each of the following types of knowledge is needed in order to understand a proof of this result. Please choose all applicable and put them in the parentheses (    ).

1) How to solve linear equations
2) How to solve equations
3) How to complete the square of a trinomial
4) How to add and subtract complex numbers.

5. The area of a parallelogram can be calculated by multiplying the length of its base by its altitude.




Please choose an example of a parallelogram from a, b, and c to which students might fail to apply this formula and put a, b, or c in the parentheses (      ).




6. A teacher gave the following problem to her class.
The numbers in the sequence 7, 11, 15, 19, 23, … increase by 4. The numbers in the sequence 1, 10, 19, 28, 37, … increase by nine.
The number 19 is in both sequences.
If the two sequences are continued, what is the next number that is in BOTH the first and the second sequence?
(a) What id the correct answer to this problem? ________

(b) A student gave the responses 27 and 46 to the question above. What is the most reason for this response?

| |
|---|
| |

7. A student asks you: I don’t understand why (-1) * (-1) = 1.

Please outline as many different ways as possible of explaining this mathematical fact to your student.

## Appendix II Chinese Version of the Survey

中国数学教师问卷

尊敬的数学老师，

我是一名教师教育专业的博士生，就读于内华达大学，拉斯维加斯分校教育学院教学系。我现在邀请您参加一项关于中学数学教师学科教学知识的研究。这项研究的目的在于探讨数学教师个人教学效能和集体效能对教师学科教学知识的影响。您需要 20−30 分钟完成这个问卷。我相信您的参与和支持不仅能帮助我完成这项研究，而且能帮助您思考您的教学活动，从而提高教学水平。真诚感谢您的参与和支持。谢谢！

### 第一部分 背景信息

请回答下列每一个问题。请您填写或者在选择的答案上划勾“✔”

1. 我同意参与这项研究并回答下列所有问题： 是（　　）；否（　　）
2. 性别： 男 (　); 女 (　)
3. 我当教师已有（　　）年并教过以下学科：
   请注明：____________________ 。
4. 我当数学教师已有（　　）年。
5. 我在现在学校当数学教师已有（　　）年, 并教过以下年级的数学：
   请注明：____________________ 。
6. 我所受的专业训练是： 数学（　）；数学教育（　）；小学教育（　）；中学教育（　）；其他 （请注明：_________ ）
7. 我的最高学历：博士（　）；硕士（　）；本科（　）；专科（　）；中专 / 中师（　）；其他（请注明：__________________ ）
8. 我现在所任教年级是：初一（　）；初二（　）；初三（　）；高一（　）；高二（　）；高三（　）
9. 请写下您任教学校的名称：　　　　　　　　　　　。
10. 我们学校有（　　）名数学老师。
11. 我们教研组有（　　）名数学数学老师。
12. 我们学校要求我和我的同事们使用统一或相似的课程材料教数学。是（　　）；否（　　）
13. 我们学校要求我和我的同事们定期讨论如何提高学生的数学学习。是（　　）；否（　　）
14. 我们学校采用校外的测验材料考核学生的单元或者学期数学学习。是（　　）；否（　　）
15. 我们学校要求我和我的同事们一起备课。是（　　）；否（　　）
16. 我们学校要求我和我的同事们互相听课。是（　　）；否（　　）
17. 我们学校要求我和我的同事们互相评课。是（　　）；否（　　）
18. 我们学校要求我和我的同事们定期讨论如何考核学生的数学学习。是（　　）；否（　　）
19. 我的学校要求我和我的同事们一起分析学生的成绩。是（　　）；否（　　）

您和您的同事是否经常从事下列教学活动。请您在选择您在选择的答案上划勾“✔”。

| | 从不 | 每学期一次 | 每月一次 | 每周一次 | 一周两次 |
|---|---|---|---|---|---|
| 20. 一起备课 | 1 | 2 | 3 | 4 | 5 |
| 21. 互相观摩教学 | 1 | 2 | 3 | 4 | 5 |
| 22. 其他老师观摩您的教学 | 1 | 2 | 3 | 4 | 5 |
| 23. 分享和研讨有效的数学教学实践 | 1 | 2 | 3 | 4 | 5 |
| 24. 分享和讨论如何提高学生的数学学习 | 1 | 2 | 3 | 4 | 5 |
| 25. 开发数学教学材料 | 1 | 2 | 3 | 4 | 5 |
| 26. 互相评课和提供反馈 | 1 | 2 | 3 | 4 | 5 |
| 27. 研讨如何考核学生的数学学习 | 1 | 2 | 3 | 4 | 5 |
| 28. 分析学生的考试成绩 | 1 | 2 | 3 | 4 | 5 |
| 29. 分享数学教学和学习的理念 | 1 | 2 | 3 | 4 | 5 |

## 第二部分 数学教师个人效能问卷

请您认真阅读每个条目。请在您认为最适合您的选项上打勾“✔”，1 代表“非常不同意”, 5 代表“非常同意”。您的答案没有对错之分。

| | 非常<br>不同意 | 不<br>同意 | 不<br>确定 | 同意 | 非常<br>同意 |
|---|---|---|---|---|---|
| 1. 即使我非常努力，我还是不能教好数学。 | 1 | 2 | 3 | 4 | 5 |
| 2. 我知道如何有效地教数学概念。 | 1 | 2 | 3 | 4 | 5 |
| 3. 在组织数学教学活动时，我觉得不是非常有效。 | 1 | 2 | 3 | 4 | 5 |
| 4. 我的数学教学通常不是很有效。 | 1 | 2 | 3 | 4 | 5 |
| 5. 我对数学概念有较好的理解足以使我教好数学。 | 1 | 2 | 3 | 4 | 5 |
| 6. 我发现用教具向学生解释数学原理非常困难。 | 1 | 2 | 3 | 4 | 5 |
| 7. 我通常能够回答学生的数学问题。 | 1 | 2 | 3 | 4 | 5 |
| 8. 如果给我选择，我不会邀请我的校长评估我的数学教学。 | 1 | 2 | 3 | 4 | 5 |
| 9. 当学生理解一个数学概念有困难时，我不知道如何帮助他/她。 | 1 | 2 | 3 | 4 | 5 |
| 10. 上数学课时，我通常欢迎学生提问题。 | 1 | 2 | 3 | 4 | 5 |
| 11. 我不知道如何做才能使学生学好数学。 | 1 | 2 | 3 | 4 | 5 |

## 第三部分 数学教师集体效能问卷

请您认真阅读每个条目。请在您认为最适合您的选项上打勾"✔"，1 代表"非常不同意", 5 代表"非常同意"。您的答案没有对错之分。

| | 非常不同意 | 不同意 | 不确定 | 同意 | 非常同意 |
|---|---|---|---|---|---|
| 1. 我们教研组的老师有能力促进学生的学好数学。 | 1 | 2 | 3 | 4 | 5 |
| 2. 我们教研组的老师能够教育好问题学生。 | 1 | 2 | 3 | 4 | 5 |
| 3. 我们教研组的老师相信能够激发学生学习数学的动机。 | 1 | 2 | 3 | 4 | 5 |
| 4. 我们教研组的老师相信每个学生都能学好数学。 | 1 | 2 | 3 | 4 | 5 |
| 5. 我们教研组的老师对所任课程受过良好的训练。 | 1 | 2 | 3 | 4 | 5 |
| 6. 我们教研组的老师能够熟练运用各种教学方法。 | 1 | 2 | 3 | 4 | 5 |
| 7. 我们教研组的老师互相分享教学理念。 | 1 | 2 | 3 | 4 | 5 |
| 8. 我们教研组的老师观摩彼此的教学并提出反馈。 | 1 | 2 | 3 | 4 | 5 |
| 9. 我们教研组的老师分享和讨论学生的作业。 | 1 | 2 | 3 | 4 | 5 |
| 10. 我们教研组的老师讲课对外开放。 | 1 | 2 | 3 | 4 | 5 |
| 11. 我们教研组的老师分析讨论学生成绩结果。 | 1 | 2 | 3 | 4 | 5 |
| 12. 我们教研组的老师讨论那些不太成功的讲课例子。 | 1 | 2 | 3 | 4 | 5 |
| 13. 我们教研组的老师一起备课。 | 1 | 2 | 3 | 4 | 5 |
| 14. 我们教研组的老师参与跨班级的数学教学活动。 | 1 | 2 | 3 | 4 | 5 |
| 15. 我们教研组的老师认为他们有责任互相帮助。 | 1 | 2 | 3 | 4 | 5 |
| 16. 我们教研组的老师彼此讨论我们在学术研讨会或者教学培训时所学的知识。 | 1 | 2 | 3 | 4 | 5 |
| 17. 我们教研组的老师觉得同事间应互相支持。 | 1 | 2 | 3 | 4 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| 18. 我们教研组的老师一起分享成功的教学实践。 | 1 | 2 | 3 | 4 | 5 |
| 19. 我们教研组的老师一起准备教学材料和活动。 | 1 | 2 | 3 | 4 | 5 |
| 20. 我们教研组的老师一起讨论如何帮助数学学习有困难的学生。 | 1 | 2 | 3 | 4 | 5 |
| 21. 我们教研组的老师觉得应对学生的学习负有责任。 | 1 | 2 | 3 | 4 | 5 |
| 22. 我们教研组的老师拥有相似的教学理念。 | 1 | 2 | 3 | 4 | 5 |
| 23. 我们教研组的老师觉得应该对彼此教学负有责任。 | 1 | 2 | 3 | 4 | 5 |

## 第四部分 数学教学问卷

请要仔细阅读每个条目。因为每个问题的提问方式不同，您需要回答每一个问题的每个条目。有些问题需要您写下答案。

1. 下面这个问题出现在中学低年级课本里。李强，王硕和张超一起玩玻璃球游戏。他们一共有 198 个玻璃球。李强的玻璃球是王硕的 6 倍，张超的玻璃球是王硕的 2 倍。请问他们每个人有多少个玻璃球？

请把您的答案写在括号里:李强(　　　)个；王硕(　　　)个；张超(　　　)个。

2. 下面这个问题出现中学低年级课本里。郝伟，孙立和赵童一起玩玻璃球游戏。他们一共有 198 个玻璃球。郝伟的玻璃球是孙立的 6 倍，是赵童的 3 倍。请问他们每个人各有多少个玻璃球？

请把您的答案写在括号里:郝伟(　　　)个；孙立(　　　)个；赵童(　　　)个。

对中学生来说您所做的第二题比第一题难度要大些。请您解释为什么第二题比第一题难度大，并将您的答案写在下面的方格内。

| |
|---|
| |

3. 三个低年级的初中生，钱明，王丽和黄鹤要证明一道题:三个连续的自然数相乘所得的积数是6的倍数。

下面是三个学生的证明过程:

钱明的答案:6 的倍数必须有 2 和 3 作为因子；

如果三个连续的自然数，其中一个一定是 3 的倍数；

并且，至少三个数中的一个数是奇数，另两个偶数一定是 2 的倍数；

如果把这三个连续自然数乘起来，答案必须至少有一个 3 作为因子，一个 2 作为因子。

王丽的答案:

1 * 2 * 3 ＝ 6

2 * 3 * 4 ＝ 24 ＝ 6 * 4

4 * 5 * 6 ＝ 120 ＝ 6 * 20

6 * 7 *8 ＝ 336 ＝ 6 * 56

黄鹤的答案: n 是任何整数，$n * (n+1) * (n + 2) = (n^2 + n) * (n + 2) = n^3 + n^2 + 2n^2 + 2n$

销掉 n，就得到 1 ＋ 1 ＋ 2 ＋ 2 ＝ 6.

请问三个学生的答案谁的是正确的。请在相应的括号里划勾“3”。

钱明:（正确　　）或者（错误　　）

王丽:（正确　　）或者（错误　　）

黄鹤:（正确　　）或者（错误　　）

4. 一个数学老师想演示如何解一元二次方程。请判断下面哪些项知识对于解一元二次方程很关键。请选择所有可能的答案，在相应的括号内划勾“3”。

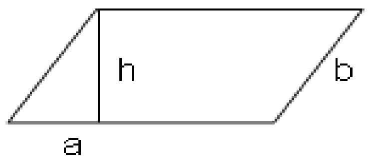
a. 如何解一元一次方程 （　　）

b. 如何解 $x^2 = k$ 格式的方程，其中 $k > 0$ （　　）

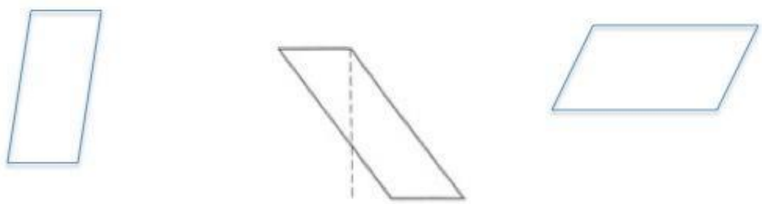
c. 如何分解二次三项式 （　　）

d. 如何加减复数　　　（　　）

5. 平行四边形的面积可以通过底边长乘以高来计算。平行四边形的面积＝底×高




请问下面三个图中哪一个图，学生有可能不会用平行四边形面积公式来计算面积。
请选择您的答案，在相应的括号里划勾“3”：a（　 ）；b（　　）；c（　　 ）



a　　　　　　　b　　　　　　　c

6. 一位数学老师给学生出了下面的问题。在一个数字序列 7，11，15，19，23，…中，数字依次增加4；在另一个数字序列 1，10，19，28，37，…中，数字依次增加9。数字19出现在两个序列中。如果两个序列继续增加，那么下一个出现在两个序列中的数是多少？

(a) 请选择这个问题的正确答案，并在括号内划勾“✔”：44（　 ）；55（　　）；64（　 ）

(b) 一个学生给出的答案是 27 和 46。请分析他如何思考才能得出这个答案。请将您的解释写在下面的方格内。

7. 一个学生对您说，我不懂为什么(-1)乘以(-1)等于 1。请您提供几种解释，并将您的答案写在下面的方格内。

## Appendix III Institutional Review Board (IRB) Approvals

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

### Social/Behavioral IRB – Exempt Review
### Deemed Exempt

**DATE:** **February 7**, 2013

**TO:** **Dr. Jian Wang,** Teaching and Learning

**FROM:** Office of Research Integrity – Human Subjects

**RE:** Notification of IRB Action
Protocol Title: **Impacts of Teacher Self-Efficacy, Collective Teacher Efficacy on Teachers' Pedagogical Content Knowledge**
Protocol # 1301-4350

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This memorandum is notification that the project referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46 and deemed exempt under 45 CFR 46.101(b)2.

**PLEASE NOTE:**
Upon Approval, the research team is responsible for conducting the research as stated in the exempt application reviewed by the ORI – HS and/or the IRB which shall include using the most recently submitted Informed Consent/Assent Forms (Information Sheet) and recruitment materials.

*Any* changes to the application may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a **Modification Form**. When the above-referenced project has been completed, please submit a **Continuing Review/Progress Completion report** to notify ORI – HS of its closure.

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.

Office of Research Integrity – Human Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805

Assessment, Accountability, Research, and School Improvement • Research Dept.

4212 Eucalyptus Ave. • Las Vegas, NV 89121 • (702) 799-5195 • FAX (702) 799-0292

CCSD

CLARK COUNTY

SCHOOL DISTRICT



December 27, 2013

Qingmin Shi
University of Nevada, Las Vegas
4505 S Maryland Parkway Box 453005
Las Vegas, NV 89154-3005

Dear Qingmin:

The Research Review Committee of the Clark County School District has reviewed your request entitled: *Impacts of Teacher Efficacy and Collective Teacher Efficacy on Pedagogical Content Knowledge.* The committee is pleased to inform you that your proposal has been approved with the following provisos:

1. Participation is strictly and solely on a voluntary basis,
2. Approval granted for middle schools listed here that provided the original signed Facility Acknowledgement letters: Bridger, Fremont, Harney, Keller, and Von Tobel.
3. Provide letter of acknowledgement from additional principals who agree to be involved with the study.

This research protocol is approved for a period of one year from the approval date. The expiration of this protocol is December 26, 2014 December 26, 2014 December 26, 2014. If the use of human subjects described in the referenced protocol will continue beyond the expiration date, you must provide a letter requesting an extension *one month* prior to the expiration date. The letter must indicate whether there will be any modifications to the original protocol. If there is any change to the protocol it will be necessary to request additional approval for such change(s) in writing through the Research Review Committee.

**Please provide a copy of your research findings to this office upon completion.** We look forward to the results. If you have any questions or require assistance please do not hesitate to contact Brett Campbell at (702) 799-5195 or e-mail at bdcampbell@interact.ccsd.net.

Sincerely,

Lisa A. Pitch
Coordinator III
Department of Accountability & Research
Chair, Research Review Committee

clk
c: Brett Campbell
Research Review Committee

RRC-020-2014

*Main Office:* 5100 WEST SAHARA AVENUE • LAS VEGAS, NEVADA 89146 • TELEPHONE (702) 799-5000

INFORMED CONSENT

Department of Teaching & Learning

**TITLE OF STUDY**: Impacts of Teacher Self-Efficacy, Collective Teacher Efficacy on Pedagogical Content Knowledge

PRINCIPAL INVESTIGATOR: Jian Wang, Ph.D.
STUDENT INVESTIGATOR: Qingmin Shi

**Contact Information**
If you have any questions or concerns about the study, you may contact Jian Wang, Ph.D. at 702-895-1750 or by email at wangj2@unlv.nevada.edu or you may contact Qingmin Shi at 702-895-0818 or by email at shiq@unlv.nevada.edu.

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted, you may contact the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794 or via email at IRB@unlv.edu.

**Purpose of the Study**
You are invited to participate in a research study. The purpose of this study is to explore the relationship between teacher self-efficacy and collective teacher efficacy, and how these two types of efficacy influence teachers' pedagogical content knowledge. As participants you are being asked to participate in the study because you are currently working as a 6th-12th mathematics teacher.

**Procedures**
If you volunteer to participate in this study, you will only be asked to answer survey questions.

**Benefits of Participation**
There will not be direct benefits to you as a participant in this study. However, we hope that you will have a deeper understanding of teacher self-efficacy and collective teacher efficacy and their influences on pedagogical content knowledge.

**Risks of Participation**
There are risks involved in all research studies. This study may include only minimal risks. Although we do not anticipate any significant risks, you may be uncomfortable answering some of the questions.

**Cost /Compensation** There will not be financial cost to you to participate in this study. The study will take 20-30 minutes of your time. You will not be compensated for your time.

**Confidentiality**
All information gathered in this study will be kept as confidential as possible. No reference will be made in written or oral materials that could link you to this study. All records will be stored in

a locked facility at UNLV for three years after completion of the study. After the storage time the information gathered will be destroyed completely, electronic media will be erased and/de-identified.

**Voluntary Participation**

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with UNLV. You are encouraged to ask questions about this study at the beginning or any time during the research study.

**Participant Consent**: I have read the above information and agree to participate in this study. I have been able to ask questions about the research study. I am at least 18 years of age. A copy of this form has been given to me.

A COPY OF THIS CONSENT FORM SHOULD BE DOWNLOADED, SAVED AND/OR COPIED FOR YOUR OWN RECORDS.

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## EDUCATION

**University of Nevada, Las Vegas**
Ph.D. in Teacher Education, with an emphasis in Research Methodology in Teaching, Learning, and Teacher Education, 2016

**Beijing Normal University, Beijing, China**
Ph.D. in Developmental and Educational Psychology, with an emphasis in Educational Social Psychology in K-12 and Higher Education, 2003

**Hebei Normal University, Shijiazhuang, China**
M.A. in Psychology, with an emphasis in Psychological Theories and Applications, 1996

**Hebei University, Baoding, China**
B.A. in Education, with an emphasis in Educational Administration, 1992

## PROFESSIONAL EXPERIENCES

| | |
|---|---|
| 2014 - Present | Quantitative Analyst<br>Office of Institutional Research, Office of the Provost<br>Nevada State College |
| 2011 - 2014 | Research Assistant, Instructor<br>Department of Teaching and Learning, College of Education<br>University of Nevada, Las Vegas |
| 2009 - 2011 | Research Assistant, Instructor, and Site Facilitator<br>Department of Curriculum and Instruction, College of Education,<br>University of Nevada, Las Vegas |
| 2005 - 2006 | Research Assistant of the ACCESS Grant Evaluation<br>The Program for Research and Evaluation in Public Schools (PREPS),<br>Old Dominion University |

2004 - 2005 Research Associate of the New Portals to Appreciating our Global Environment (NewPAGE) Evaluation
Department of Educational Curriculum and Instruction
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2003 - 2004 Research Consultant
Fanxi Road Elementary School, Shijiazhuang, China

2002 - 2008 Associate Professor
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Hebei Normal University, Shijiazhuang, China

2001 - 2003 Grant Coordinator
School of Psychology at Beijing Normal University and Shenzhen Guangming Middle School, Shenzhen, China

2000 - 2003 Research Assistant and GA Team Leader
Department of Psychology, School of Psychology
Beijing Normal University, Beijing, China

2000 - 2003 Research and Teaching Consultant
Beijing Jinsong Fourth Elementary School, Beijing, China

1997 - 1999 School Psychologist, Shijiazhuang 28th Middle School

1997 - 2002 Assistant Professor of Psychology
Department of Psychology, Hebei Normal University

1996 - 1997 Lecturer of Psychology
Department of Psychology
Hebei Normal University, Shijiazhuang, China

1987 - 1993 Lecturer of Psychology
Langfang Normal School, Langfang, China

## PEER-REVIEWED PUBLICATIONS


**Shi, Q.** (2014). Relationship between teacher efficacy and self-reported instructional practices: An examination of five Asian countries/regions using TIMSS 2011 data. *Frontiers of Education in China*, *9*(4), 577-602.

**Shi, Q.**, Zhang, S., & Lin, E. (2014). The relationships of new teachers' beliefs and instructional practices: Comparisons across four countries. *Action in Teacher Education, 36*(4), 322-341.

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**Shi, Q.**, Zhang, S., & Luo, X. (2008). Cross-cultural comparison on teaching effects of teacher self-disclosure. *Teacher Education Research, 3*, 45-49.

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**Shi, Q.**, Jin, S., Dai, Y., & Ma, Y. (2004). Relationship between the self-presentation in the classroom and self-concept of elementary school students. *Shanghai Research on Education*, *5*, 41-43.

**Shi, Q.**, Jin, S., & Takashi Yamada (2003). Comparative research on DTI of Sino-Japanese adolescences. *Studies in Foreign Education*, *2*, 21-24.

**Shi, Q.**, Jin, S., & Takashi Yamada (2003). Comparative research on EMBU of Sino-Japanese adolescences. *Family Education in China*, *2*, 21-24.

Zhang, Y., Wang, J., & **Shi, Q.** (2003). Job burnout: A special syndrome of job stress. *Medicine and Philosophy*, *24*(10), 63-64.

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**Shi, Q.**, & Wang, Z. (2001). A psychological guide to the college graduates for their employment. *Journal of Hebei Normal University (Educational Science Edition)*, 3(4), 69-72.

Liu, Y., **Shi, Q.** (2001). Seeking for Li Zhi's psychological thoughts of personality. *Journal of Shijiazhuang College of Profession and Technology*, *1*, 168-169.

Zhai, H., **Shi, Q.**, & Huang, X. (2000). Influencing factors in the formation of middle school students' sense of self-worth. *Psychological Science*, *23*(4), 408-411.

**Shi, Q.**, & Ding, G. (2000). Research on computer test anxiety of college students. *Journal of Health Psychology*, *8*(3), 273-274.

**Shi, Q.** (1999). Research methods on the functions of cerebral hemisphere. *Journal of Hebei Normal University (Educational Science Edition)*, *1*(2), 14-17.

**Shi, Q.** (1998). Test anxiety and guide for middle school students. *Journal of Hebei Normal University (Educational Science Edition)*, *1*(4), 238-239.

Shi, Q., Zhang, S. & Li, S. (1998). English learning characteristics of college students. *Journal of Economic College in Shijiazhuang, 12,* 134-135.

**Shi, Q.** (1998). Encounter of famous people. *Mental World*, *5*, 40-42.

**Shi, Q.** (1997). Liu Shao's thoughts on how to know the talent. *Journal of Hebei Normal University (Philosophy and Social Science Edition), 4,* 120-122.

**Shi, Q.** (1996). Research on mental states of retired college teachers. *Journal of Hebei Normal University (Philosophy and Social Science Edition)*, *4*, 120-121.

**Shi, Q.** (1995). Normal school preservice teachers' motivations for teaching. *Mathematical Statistics and Research*, 12, 90-92.

**AWARDS**

2013 - 2014, **Recipient**, *the Edward Pierson Scholarship*, College of Education, University of Nevada, Las Vegas.

2013, **Recipient,** Second place for the paper presented at the Annual Graduate Research Forum (Education section), Graduate and Professional Student Association (GPSA), Graduate College, University of Nevada, Las Vegas.

2012 - 2013, **Recipient,** *Graduate Merit Award*, Graduate and Professional Student Association (GPSA), Graduate College, University of Nevada, Las Vegas.

2011 - 2012, **Recipient**, *the John M. Vergiels Scholarship*, College of Education, University of Nevada, Las Vegas.

2011, **Recipient**, Training on "Using the Schools and Staffing Survey (SASS) and Teacher Follow-up Survey (TFS) for Research and Policy Discussion", Sponsored by the National Center for Education Statistics (NCES) and U.S. Department of Education.

2010 - 2011, **Recipient,** *Graduate Merit Award*, Graduate and Professional Student Association (GPSA), Graduate College, University of Nevada, Las Vegas.

2010, **Recipient**, Training on "*Using the NCES International Databases for Research and Discussion"*, Sponsored by the National Center for Education Statistics (NCES), the Institute of Education Sciences, and U.S. Department of Education.

2010, **Recipient** of the *Book Scholarship*, Graduate and Professional Student Association (GPSA), Graduate College, University of Nevada, Las Vegas.

2009 - 2013, **Recipient**, *Graduate Travel Awards*, Department of Teaching and Learning University of Nevada, Las Vegas

2009 - 2013, **Recipient**, *Graduate Travel Grants*, Graduate and Professional Student Association (GPSA), Graduate College, University of Nevada, Las Vegas.

2009 - 2013, **Recipient**, *UNLV ACCESS Grant*, Graduate College, University of Nevada, Las Vegas.