BELIEVING AND PERCEIVING: EXAMINING U.S. AND CHINESE MATHEMATICS TEACHERS' BELIEFS AND NOTICING PATTERNS

By

Marissa M. Zhu

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ABSTRACT

This dissertation is a two-part study comparing U.S. and Chinese teachers' beliefs and noticing patterns. The overarching question for this study is: "How does culture influence what mathematics teachers believe and notice?" This project seeks to investigate this central assumption: there are distinctly "Western" and "East Asian" pedagogical features that inform what teachers believe and notice about teaching and learning. Paper one seeks to clarify the role of cultural stereotypes in shaping teachers' personal beliefs and perceptions of their culture's beliefs on teaching and learning. In Paper two, group differences between U.S. and Chinese teachers' beliefs and noticing are analyzed with respect to these stereotypical pedagogical features (SPFs).

This project combines two research areas, cross-cultural comparisons of teachers' beliefs and cross-cultural studies of teacher noticing, to present a distinction of the pedagogical features that seem to underlie Western and East Asian teachers' practices. This dissertation takes a unique approach to assessing teachers' pedagogical beliefs. Across both studies, teachers' personal beliefs are assessed separately from their cultural beliefs. Further, the concept of "cultural beliefs" is defined as an individual's *perception* of the shared values held by most members of a cultural group, as well as social structures such as the relationship between parents and children or the relationship between teachers and students (Leung, 2006).

Findings of these studies indicate that the cultural distinctions between "Western" and "Eastern" are becoming blurred as East Asian educators, such as the Chinese participants in this study, take up more "Western" pedagogical theories and practices. Chinese teachers' personable beliefs indicate a definite shift towards "Western"-oriented features such as child-centeredness, process-orientation, and intrinsic motivation, even as they perceive China's cultural orientation

as being more “Eastern” (Study One). But a closer examination of Chinese teachers’ perceptions of a student-centered lesson compared to a teacher-directed lesson tells a different story: teachers’ interpretations and responses continue to both impart and reflect stereotypically “Eastern” features (Study Two). At first blush, these findings seem to reinforce the claim that Chinese teachers are more likely to notice “Eastern” features because of cultural preferences for teacher-directed instruction. In contrast to previous claims, however, this dissertation argues that certain “Eastern” features—such as *abstract representation*, *subject matter knowledge*, and *highly-structured* lessons— are conducive for supporting student-centered noticing, particularly in addressing students’ mathematical thinking.

The significance of these findings is discussed in terms of finding a balanced perspective that draws upon the strengths of “Western” and “East Asian” paradigms to develop a more holistic model of teacher practice. This perspective is discussed in terms of how it may inform cross-cultural approaches to developing student-centered noticing skills, and future research in teacher noticing and beliefs.

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INTRODUCTION

Statement of the Problem

There is a global shift towards student-centered and complex teaching in mathematics education (Kim, 2019). Student-centered teaching is touted as the "globally preferred pedagogical model" amongst Western and East Asian countries alike (p. 371). East Asian countries, including China, have reformed their national mathematical curriculum standards to align with more student-centered practices, such as attending to students' mathematical thinking and motivation over the past two decades (Guo et al., 2018; Kim, 2019). At the same time, the U.S. has adopted more rigorous mathematics standards, one that emphasizes solid mathematical content knowledge and procedural skills (NCTM, 2020). Against the current backdrop of reform, there is a natural tendency to compare and emulate teaching practices from different countries.

The 2020 National Council of Teachers of Mathematics (NCTM) standards for middle school mathematics point to new priorities for mathematics education in the U.S. in order to better prepare an increasingly diverse body of students for college mathematics. Compared to its 2012 predecessor, the 2020 NCTM emphasizes more rigorous mathematics content, developing teachers' subject-specific content knowledge, and more defined standards for mathematical modelling. The most notable change is the inclusion of equitable learning practices and structures. To be clear, these changes do not signal a shift away from core Western beliefs (e.g., conceptual understanding precedes procedural fluency) and values (e.g., active participation, individualized learning, and mathematical thinking) about mathematics education. If anything, the 2020 NCTM standards presents these principles in sharper focus than its predecessor. The revised standards maintain these Western ideals while integrating key principles from traditional Chinese mathematics education, which emphasizes the importance of developing a strong base

of mathematical content knowledge and procedural skills ("The Two Basics") (Zhang, Li & Tang, 2005).

At the same time, Chinese mathematical curriculum standards have adopted Western paradigms of teaching. In 2000, the Ministry of Education commissioned a group of researchers to develop the Mathematics Curriculum Standards for Compulsory Education (MCSFCE) in order to establish a national curriculum. This curricular reform was driven by the need for greater mathematical literacy in response to rapid social and economic developments made possible by democratization and technological innovation (Wang et al., 2017). Though the MCSFCE retains its emphasis on the "two basics" (Zhang, Li & Tang, 2005), the MCSFCE also focuses on real-world applications and student motivation (Guo et al., 2018).

The current iteration of the MCSFCE, released in 2011, continues the trend of adopting Western ideals. For instance, the new edition of MCSFCE emphasizes students' mathematical thinking and problem-solving skills. attention to result teaching (Guo et al., 2018). For instance, the MCSCES states that students should be able to express their own mathematical ideas as well as understand others' mathematical thinking. With respect to problem solving, MCSCES suggests that students should progress "from simply finding solutions to problems under the guidance of their teachers to becoming autonomous problem solvers who can determine the mathematical appropriateness of problem solutions and solution methods they produce." (p. 1316).

Taken together, these shifts indicate that both U.S. and Chinese models of mathematics education are moving towards a more integrative approach, one that draws from the strengths of each paradigm. As U.S. national standards for mathematics education adopts a more rigorous

approach to developing mathematical content and skills, Chinese national standards are emphasizing student communication and self-directed learning.

However, teaching practices are not easily imported from one country to another. Transforming teacher practice begins with supporting teachers' ability to notice and learn from instructional methods in other cultures. What teachers pay attention to and how they respond to instructional practice are influenced by what they know and believe about teaching (Stahnke et al., 2016). Studies show that East Asian classrooms have maintained teacher-centered pedagogical practices despite student-centered reform efforts (Kim 2018; 2019). Meanwhile, national trends on U.S. student achievement show that despite the increasing emphasis on standardized testing, average mathematics scores in both reading and math declined from 2012 to 2020 for 13-year-old students, the first drop recorded in a half-century (National Center for Education Statistics, 2021).

A popular explanation is that culturally rooted beliefs about teaching and learning may act as an "ideological buffer" against accepting new standards and practices (Kim, 2019; Tobin et al., 2009). What teachers pay attention to and how they respond to instructional practice are influenced by their beliefs about teaching and learning (Stahnke et al., 2016). Scholars argue that Western and East Asian cultures hold different philosophies regarding teaching and learning and about mathematics in particular (Leung, 2001; Leung et al., 2006; Tweed & Lehman, 2003). "Western" pedagogical approaches are widely considered to be more student-centered, whereas "Eastern" pedagogy is often described as being more teacher-directed (Leung, 2001; Biggs, 1996). Cross-cultural researchers often rely on these stereotypical characterizations of "Western" and "Eastern" pedagogy to interpret differences in teacher practice.

It is important to understand how teachers' belief systems may support or inhibit their ability to notice classroom events in ways that support student-centered teaching in order to facilitate better cross-cultural learning between the U.S. and China. Teachers' noticing ability is central to, and integrated within, the ability to provide instruction that is appropriately responsive and adaptive to students' needs (Gibson & Ross, 2016). Understanding these beliefs may help us better understand how to provide targeted support for Western and East Asian educators' development of student-centered noticing.

Study Rationale

The overarching purpose of this dissertation is to critically examine two commonly-held assumptions found in the cross-cultural literature: first, there are distinctly "Western" and "Eastern" pedagogical features— stereotypical pedagogical features (SPFs)— that continue to shape current teachers' pedagogical orientations (Tobin et al., 2009; Leung, 2001; Bryan et al., 2007); second, stereotypically "Western" more compatible with student-centered instruction whereas "Eastern" features are better suited for teacher-directed instruction (Han & Jarvis, 2013; Leung, 2005; Morris & Marsh, 1992).

To investigate the first claim, I take a multi-faceted approach to investigating teachers' pedagogical orientations: (1) what teachers believe about mathematics education (pedagogical beliefs) and (2) how they perceive different instructional styles (teacher noticing). Together, these constructs offer insight into how teachers' *professed* views on teaching and learning compare with *actual* responses to instructional practices that are similar or different from their own. This allows me to compare U.S. and Chinese teachers' explicit and implicit beliefs about how mathematics should be taught and learned, as well as to tease out the role of culture in shaping these beliefs.

To address the second claim, this study investigates which U.S. and Chinese teachers' beliefs and noticing are consistent with student-centered pedagogy. If the current assumption that "Western" pedagogy is more compatible with student-centered teaching holds true, then it should be expected that the U.S. teachers should express beliefs and notice in ways that emphasize attending to students' mathematical thinking, student interest, and inquiry-based learning (Zolfaghari et al., 2021). Since "Eastern" pedagogy is more teacher-directed, the Chinese teachers' beliefs and noticing patterns should reflect a tendency to emphasize classroom control, direct instruction, and repeated practice (Bryan et al., 2007).

Research Questions

We need to explore U.S. and Chinese teachers' pedagogical beliefs at the level of the individual as well as the collective. It is critical to distinguish between teachers' personal pedagogical beliefs (T-PB) and their perceptions of their culture's pedagogical beliefs (TP-CPB) in order to tease out the specific influence of culture on what teachers notice. It also allows for an examination of the extent to which teachers' beliefs (both personal and cultural) and noticing patterns conform to or contradict "Western" and "East Asian" SPFs.

The global shift towards student-centered pedagogy is expected to impact teachers' personal teaching philosophies. Thus, I hypothesize that both U.S. and Chinese teachers' pedagogical beliefs (T-PB) show higher agreement with "Western" SPFs (H1). Second, I anticipate teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) to conform to existing "Western" and "East Asian" stereotypes. That is, U.S. teachers' perceptions of cultural pedagogical beliefs (TP-CPB) will be more "Western"-oriented, whereas Chinese TP-CPB will be more "Eastern"-oriented (H2). This will, in turn, influence what teachers notice when observing classroom events. Therefore, U.S. and Chinese teachers will attend, interpret, and

respond to the video clips differently (H3). However, I anticipate that teachers' noticing patterns will be more in agreement with their perception of their culture's pedagogical beliefs (TP-CPB) than their personal pedagogical beliefs (T-PB) (H4).

To examine these hypotheses, my research questions are:

> **RQ1.** What are U.S. and Chinese middle school mathematics teachers' beliefs about mathematics education and to what extent are these beliefs consistent with stereotypically "Western" and "Eastern" pedagogical features?
>
> **RQ2.** How do teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) influence teacher noticing patterns?

Dissertation Structure

This section provides a general overview of the dissertation structure.

Paper one. Exploring the East-West Divide: Examining U.S. and Chinese Teachers' Beliefs about Mathematics Education

This study examines U.S. and Chinese teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) about mathematics education and the extent to which these beliefs are consistent with stereotypically "Western" and "Eastern" features of mathematics education.

Paper two. Culturally Shaped Noticing: The Role of Personal and Cultural Beliefs on Teacher Noticing

The second study compares U.S. and Chinese teachers' noticing of two types of math lessons (student-centered and teacher-directed) and explores the degree to which teachers' noticing patterns align with their personal and culturally dominant beliefs about mathematics education.

Conceptual Framework

The overarching theoretical lens guiding this dissertation is the adapted version of the Attending, Interpreting, and Responding framework (AIR framework). This framework depicts teacher noticing as an integral process that both shapes and is shaped by the teacher's pedagogical beliefs (van Es & Sherin, 2002; Kaiser et al., 2017). This study applies van Es and Sherin's (2002; 2008) seminal framework which conceptualized teacher noticing as a set of 3 interrelated skills:

- attending to critical events;
- interpreting or evaluating observed events
- responding to observed events based on what was attended to and the interpretations that were made

Teachers' belief systems act as a filter that influences teachers to attend, interpret, and respond in particular ways. The AIR framework accounts for the role of cultural norms and values— stereotypical pedagogical features (SPFs)—in shaping teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) and their personal pedagogical beliefs (T-PB), which, in turn, inform what they notice.

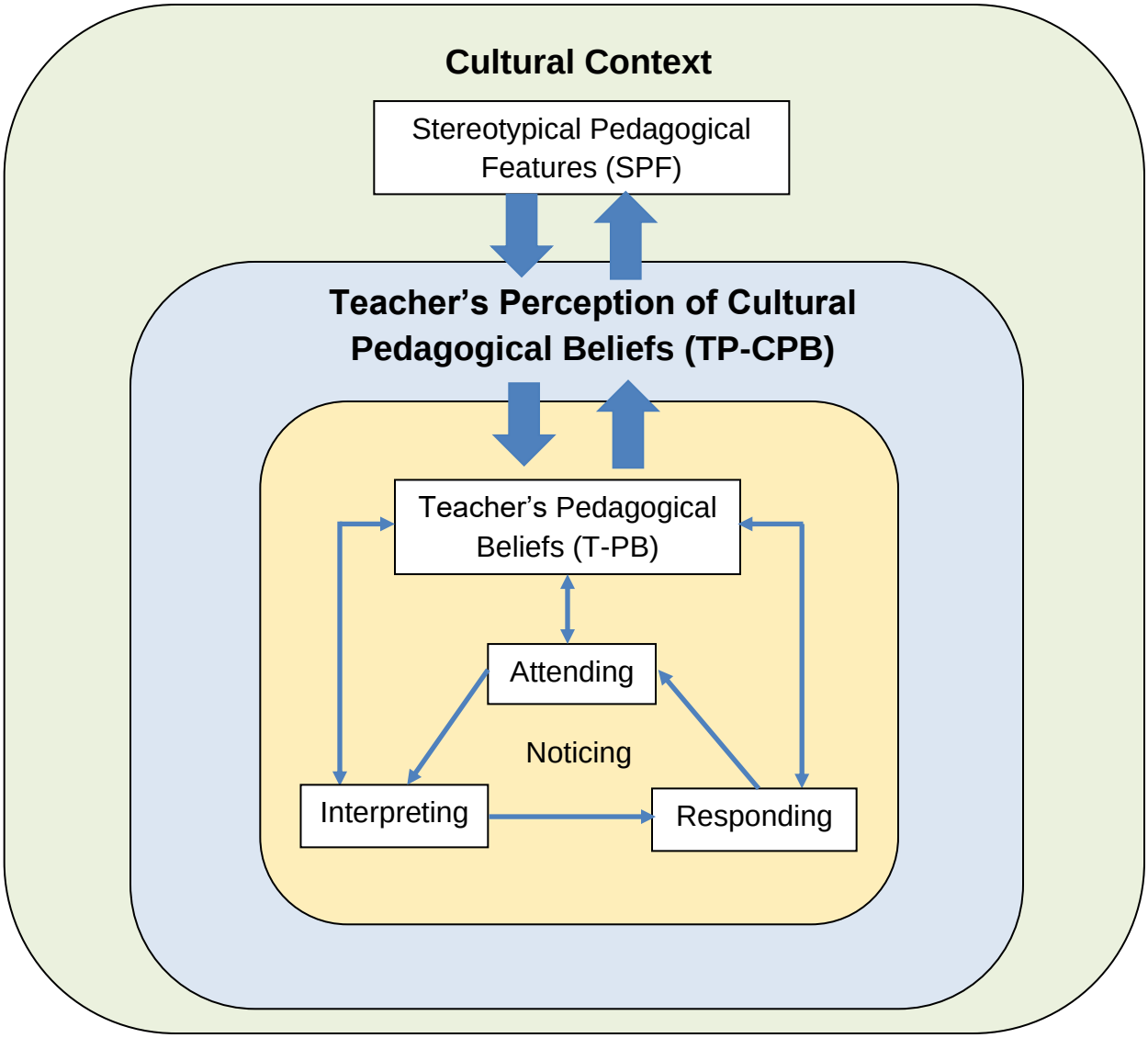

Figure I.1 Situating teacher noticing and its related components as embedded within cultural contexts (adapted from Louie et al., 2021)

Western and East Asian Features of Mathematics Education Framework

Western and East Asian Features of Mathematics Education framework (adapted from Leung, 2001) will be applied as an analytic framework. This framework will be used to analyze teachers' pedagogical beliefs and noticing patterns. The Western and East Asian Features of Mathematics Education Framework (adapted from Leung, 2001) captures key differences between Western and East Asian approaches to mathematics education along 10 dimensions: (1) *evaluation*; (2) *learning process*; (3) *teaching method* ; (4) *teacher expertise*; (5) *teacher praise*; (6) *class structure*; (7) *lesson structure*; (8) *motivation*; (9) *rote learning*; (10) *conceptual understanding*. A fuller discussion of this framework will be taken up in ***Exploring the East-West Divide: Examining U.S. and Chinese Teachers' Beliefs about Mathematics Education*** (Paper One).

Table I.1 Western and East Asian Features of Mathematics Education

Dimension	Western Perspective	East Asian Perspective
Evaluation	Process-oriented: tendency to emphasize the process of doing mathematics	Product-oriented: tendency to emphasize mathematical knowledge and skills
Learning Process	Pleasurable learning: tendency to believe that learning should be meaningful and enjoyable	Studying hard: tendency to see studying as a serious endeavor which requires hard work and perseverance
Teaching Method	Child-centered: tendency to see teaching as the facilitation of students' process of inquiry	Teacher-directed: tendency to see teaching as the transmission of knowledge from the teacher to the students

Table I.1 (cont'd)

Teacher Expertise	General pedagogical knowledge: tendency to see the role of the teacher as a facilitator with profound pedagogical competencies	Subject matter knowledge: tendency to see the role of the teacher as a scholar with profound subject-matter knowledge
Teacher Praise	Generous praise: tendency to praise students at all ability levels	Limited praise: tendency to praise exceptional student work or performance
Class Structure	Individualized learning: tendency to see teaching and learning as individualized process with the student at the center	Whole class teaching: tendency to see teaching and learning as a collective activity with the teacher at the center
Lesson Structure	Less-structured: preference for more open-ended lesson plans that allow for reflection and spontaneous discussion	High-structured lessons: preference for detailed, cohesive lesson plans with many mathematical activities
Motivation	Intrinsic motivation: tendency to emphasize the necessity of intrinsic motivators, such as student interest, as critical for student learning	Extrinsic motivation: tendency to emphasize the necessity of extrinsic motivators, such as high-stakes exams, as complementary to intrinsic motivation
Rote Learning	Memorizing to reinforce: tendency to see rote learning and memorization as a useful way to reinforce conceptual understanding	Memorizing to understand: tendency to see rote learning and memorization as a legitimate way to build conceptual understanding

Table I.1 (cont'd)

Conceptual Understanding	Concrete representation: tendency to emphasize developing mathematical understanding through hands-on learning and manipulatives	Abstract representations: tendency to emphasize developing mathematical understanding through abstract reasoning and elaboration

Definition of Terms

Culture is defined as the "shared patterns of behaviors and interactions, cognitive constructs, and affective understanding that are learned through socialization. These shared patterns identify the members of a culture group while also distinguishing those of another group" (CARLA). Thus, differences in the mathematics education systems in East Asia and the West can be understood in terms of differences in beliefs and perceptions.

Stereotypical Pedagogical Features (SPFs) Stereotypical pedagogical features (SPFs) are defined as the set of beliefs and values typically associated with "Western" or "East Asian" approaches to teaching and learning mathematics.

Teacher's Perception of Cultural Pedagogical Beliefs (TP-CPB) refers to a teacher's perception of widely held cultural beliefs about: (1) the nature of mathematics; (2) how mathematics should be taught, and (3) how students best learn mathematics. Scholars theorize that cultural pedagogical beliefs may subliminally guide teachers' attention and responses to classroom events in particular ways that may be at odds with their personal beliefs (Hand et al., 2012; Louie, 2018; Louie et al., 2021). For example, a teacher may believe that all students are equally capable of learning mathematics but may unconsciously pay more attention to certain students that live up to culturally rooted expectations of how a good student should look and behave. Thus, what teachers notice is shaped at least in part by cultural pedagogical beliefs about

teaching and learning (Lau, 2010; Louie et al., 2021). Teachers' perception of their culture's pedagogical beliefs (TP-CPB) will be assessed using Likert-scale surveys (*Personal and Cultural Beliefs about Mathematics*) and interviews.

Teacher's Pedagogical Beliefs (T-PB) is broadly defined as "psychologically held understandings, premises, or propositions" about teaching and learning (Philipp, 2007, p. 259). In mathematics education, teachers' pedagogical beliefs (T-PB) refer to teachers' views about: (1) the nature of mathematics; (2) how mathematics should be taught, and (3) how students best learn mathematics (Ernest, 1989; Speer, 2005; Thompson, 1992). Teachers' personal pedagogical beliefs are the implicit and explicit expectations that guide an individual's "attention within, interpretation of, and response to situations" (Hand et al., 2012, p. 251). Teachers' pedagogical beliefs (T-PB) will be assessed using Likert-scale surveys (*Personal and Cultural Beliefs about Mathematics*) and interviews.

Teacher noticing is defined as the process of 1) attending to critical events; 2) interpreting or assigning meaning to observed events; 3) responding to observed events based on what was attended to and the interpretations that were made (van Es & Sherin, 2008). Teacher noticing will be elicited using video-cued noticing methods (*Teacher Noticing Task*) and interviews.

Researcher's Role and Positionality

I am a Chinese American woman with a background in intercultural competence and learning. My interest in this area of study is informed by my firsthand experience in navigating the tensions between Western and East Asian approaches to schooling as a first-generation immigrant. As such, I am a member of both cultural groups I intend to study. My practicum project on developing preservice teachers' intercultural competence pointed to the ways in which cultural norms and beliefs frame teachers' perspectives on teaching and learning, as well as their

understanding of the subject matter they teach. I became interested in exploring in more detail the role of cultural stereotypes in shaping teachers' beliefs and perceptions of instructional events. The choice to focus on mathematics education in particular stems from my earlier involvement in projects exploring the integrational of instructional technologies into mathematics curricula (Rich et al., 2019). This project represents a culmination of these pursuits, and therefore its design has been strongly influenced by both my academic and personal experiences.

During data analysis, my bicultural background will aid in my interpretation of both U.S. and Chinese participants' responses. I plan to draw on my cultural knowledge and shared experiences to establish social connectedness with U.S. and Chinese teachers. I plan to draw on perceived shared experiences and cultural familiarity to invite participants to share their experiences of being exposed to, and perhaps influenced by, cultural stereotypes about teaching and learning.

I also acknowledge that my strong interest in culture may result in unconscious efforts to attribute differences in teacher noticing to culture in ways that may be unsupported by the evidence. One strategy to address this bias is to use multiple sources of data to examine the connection between cultural stereotypes on teachers' beliefs and noticing I will use separate measures of participants' beliefs to account for the role of participants' personal beliefs in shaping what they notice. For the qualitative data, explicit references to cultural sayings, norms, and beliefs will be coded as "teachers' perceptions of their culture's beliefs (TP-CPB)" whereas references to personal views and values will be coded as "teachers' pedagogical beliefs (T-PB)".

A secondary source of bias is that my understanding of East Asian and Western culture may be constrained by my personal experiences. To address this, I draw upon the relevant

literature on cross-cultural studies in mathematics education to develop a framework that identifies key features of Western and East Asian approaches to mathematics education. This a priori framework will be used to guide the analysis, coding, and interpretations of participants' data.

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PAPER ONE. Exploring the East-West Divide: Examining U.S. and Chinese Teachers' Beliefs about Mathematics Education

Abstract

What teachers do in the classroom is ultimately a product of their beliefs about teaching and learning. It is theorized that teachers from Western and East Asian countries hold pedagogical beliefs consistent with their respective cultural values. However, East Asian countries such as China have adopted certain "Western" pedagogical practices such as student-centered teaching from the U.S. and European countries over the past 20 years (Tobin et al., 2009; Tan, 2017). At the same time, the U.S. has borrowed some ideas from East Asian countries to improve American students' performance in science and mathematics (Jensen, 2012). In light of these changes, we need to examine whether long-held stereotypes about "Western" and "East Asian" pedagogy—stereotypical pedagogical features— are useful and accurate (Ryan & Louie, 2007). This study investigates the extent to which U.S. and Chinese middle school mathematics teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) are consistent with stereotypical pedagogical features (SPF) associated with Western and Eastern education (Leung, 2001). Twelve (six U.S. and six Chinese) teachers completed surveys and interviews that described their T-PB and TP-CPB about mathematics education. U.S. teachers' pedagogical beliefs (T-PB) about mathematics were consistent with "Western" features; however, teachers' perceptions of the cultural pedagogical beliefs (TP-CPB) were more mixed between "Western" and "Eastern" SPFs. Chinese teachers' pedagogical beliefs (T-PB) were more consistent with "Western" SPFs, while their perceptions of the cultural pedagogical beliefs (TP-CPB) were more consistent with "Eastern" features. These findings challenge the validity of certain "Western" and "East Asian" dichotomies (i.e., memorizing to reinforce/memorizing to

understand, intrinsic/extrinsic motivation) while they confirm that some distinctions have been preserved despite recent reforms (i.e., less-structured/highly-structured lessons, individualized learning/whole class teaching, child-centered/ teacher-directed).

Introduction

Cross-comparative studies on mathematics education highlight the role of culture in explaining East Asian countries' high performance on international achievement tests (PISA, TIMMS). There is a tendency to rely on stereotypes about "Western" and "Eastern" education to interpret differences in teaching and learning outcomes (Ryan & Louie, 2007). "East Asian" approaches to mathematics education are often presented in contrast to "Western" pedagogical features, which are typically characterized as more student-centered and progressive. However, in the past 20 years, China has adopted "Westernized" approaches to mathematics teaching, such as working with open-ended tasks, cooperative learning, and student-centered learning (Guo et al., 2018; Kim et al., 2019; Yang et al., 2021). At the same time, increasing emphasis on accountability tests has put more pressure on U.S. educators to "teach to the test" by emphasizing practice and repetition– teaching methods that are typically associated with "Eastern" pedagogy (Correa et al., 2008; Leung, 2001; Wong, 1998). Thus, stereotypical characterizations of "Western" and "East Asian" pedagogy must be critically examined in light of the dramatic social and economic transformations in China and the United States.

Review of the Literature

Historical origins of Western and East Asian pedagogy

In cross-national comparative research, Western and East Asian countries' pedagogical practices are often described in binary terms with dichotomous values and assumptions underlying each. From this line of research, it is widely recognized that there are "Western" and

"Eastern" traditions of teaching and learning. This assumption stems from the cultural demarcations that mark Western countries influenced by Greek/Constructivist traditions from countries rooted in Chinese/Confucian traditions (Leung, 2001; Leung et al., 2006; Yang et al., 2006). That is, "Western" culture encompasses Anglo-speaking countries (Australia, Canada, England, Ireland, New Zealand, South Africa, U.S.A) and Western European countries (Austria, Germany, Netherlands, Switzerland, Denmark, Finland, Sweden). "Eastern" culture refers to the countries with shared roots in Confucianism (China, Hong Kong, Japan, Singapore, South Korea, and Taiwan) (Liddell, 2005).

Western educational approaches are heavily influenced by the concept of individualism and the Socratic method (Tweed & Lehman, 2002; Watt, 1989), as reflected in popular learning theories such as constructivism. Individualism stems from the conviction that uniqueness, initiative, and autonomy are more important than group identity, conformity, and solidarity (Watt, 1989). The Socratic method posits that knowledge is self-generated through inquiry and evaluation. Together, these two principles underpin constructivist learning theories, which posit that learning is a process of knowledge creation that is unique to each individual. As Piaget argues, "the principal goal of education is to create men who are capable of doing new things, not simply repeating what other generations have done– men who are creative, inventive, and discoverers" (Golubchick & Persky, 1977, p. 97).

Constructivism is frequently contrasted with Confucianism, the predominant philosophy in East Asian countries (Ho, 2014; Yang et al., 2006). East Asian countries have a shared heritage in Confucianism, a philosophy that emphasizes prioritizing the collective over the individual. Historically, the purpose of education was to prepare students for civil service (Tweed & Lehman, 2002). For Confucius, learning is the acquisition of essential knowledge

from respected authorities. Unlike Western scholars such as Piaget and Socrates, Confucius did not stress the importance of generating new ideas: “I transmit, but I don’t innovate; I am truthful in what I say and devoted to antiquity.” (p. 45, Biggs, 1996). Because Confucius believed that knowledge is acquired by observing and learning from exemplary models, Confucius expected learners to respect and obey authority figures.

U.S. and Chinese Teachers’ Beliefs about Mathematics Education

Cross-cultural scholars argue that the underlying differences between “Western” and “Eastern” values lead to culturally distinct features of mathematics education Leung’s (2001) Leung’s *Features of East Asian Mathematics* frameworks captures these characteristics along six dichotomies: (1) *process versus product* ; (2) *pleasurable learning versus studying hard* ; (3) *individualized learning versus whole class teaching*; (4) *pedagogical knowledge versus subject matter knowledge*; (5) *meaningful learning versus rote learning* (Leung, 2001); (6) *intrinsic versus extrinsic motivation.* Below, I review and analyze the literature on U.S. and Chinese teachers’ beliefs to evaluate the empirical evidence for each dichotomy.

Process vs. product

The findings from the literature offer mixed evidence for this dichotomy. The *process vs. product* dichotomy is confirmed across several studies which reported that U.S. teachers tend to emphasize students’ process of inquiry, often encouraging novel solutions and strategies while Chinese teachers tend to emphasize the correctness of the students’ solution, strategy use, and mathematical explanations (Cai & Wang, 2010; Cai & Wang, 2006). However, more recent research suggests that Chinese mathematics teachers’ beliefs are more consistent with a process-oriented approach to teaching mathematics (Cai & Ding, 2017; Yang et al., 2020; Li et al., 2018; Li et al., 2019).

Pleasurable learning vs. studying hard

Leung's (2001) framework suggests that East Asian countries believe that learning is a serious endeavor that requires hard work and dedication whereas Western teachers believe that the learning process should be more fun and enjoyable. Chinese teachers believe that effective teaching means maintaining a level of mathematical rigor and discipline (Li et al., 2018). In contrast, Americans believe that students learn best when they enjoy the learning process (Li et al., 2019; Cai & Wang, 2010; Zhu & Leung, 2011).

Individualized learning vs. whole class teaching

The literature indicates that this dichotomy accurately characterizes current American and Chinese classroom structures and practices. Chinese teachers regularly teach class sizes of 40-60 students, making individualized instruction very difficult. Chinese teachers believe that providing, clear, explicit instruction to the whole class is important for effective learning (Bryan et al., 2007; Cai & Wang, 2010), whereas American teachers value small-group instruction or independent teaching over whole-group instruction (An et al., 2006; Li et al., 2019). American teachers' concern for attending to individual differences in learning styles and abilities is also consistent with this dimension (Correa et al., 2008).

Pedagogical knowledge vs. subject matter knowledge

The literature overwhelmingly confirms Leung's (2001) *subject matter knowledge versus pedagogical knowledge* dimension, which describes the dichotomy between what Eastern and Western teachers consider to be the most important aspect of teacher competency. Chinese teachers believe that with deep mathematical content knowledge, teachers would be able to teach mathematics at a higher level and explain mathematics in simpler ways (Cai & Wang, 2010; Li et al., 2018; An et al., 2006; Correa et al., 2008). On the other hand, U.S. teachers believe that

classroom management is a very important quality for effective teaching (Cai & Wang, 2010; An et al., 2006; Li et al., 2018).

Meaningful learning vs. rote learning

According to Leung (2001), Eastern pedagogy stresses the importance of memorization. For Eastern educators, memorizing without fully understanding something is an acceptable first step toward developing conceptual understanding. In contrast, Western educators generally believe that rote learning promotes surface-level learning and does not lead to conceptual understanding (Marton et al., 1996). However, a number of studies show that both U.S. and Chinese teachers agree that "rote learning", or repeated practice and memorization, have an important role in the learning process (Cai & Wang, 2010; Stigler & Perry, 1990). In fact, Correa et al.'s (2008) study reported that U.S. teachers placed more emphasis on practice and repetition than Chinese teachers.

Intrinsic vs. extrinsic motivation

According to Leung (2001), Western educators highly regard intrinsic motivation in teaching and learning. Western teachers believe the best way to motivate a student is to engage the students' interests. An intrinsically motivated student is driven to learn for the fun or challenge rather than because of external pressures or rewards (Ryan & Deci, 2000). In contrast, East Asian countries appear to emphasize extrinsic motivation, such as high-stakes examinations and parental expectations (Watkins & Biggs, 1996; 2000). However, multiple studies show that Chinese teachers also greatly value students' interest and creativity in learning mathematics (Correa et al., 2008; Niu, et al., 2017; Lu & Kaiser, 2022). Chinese educators hold mathematics in high regard, not purely for pragmatic purposes but also from a deep appreciation of the beauty of mathematics (Correa et al., 2008; Cai & Wang, 2010; Seah, 2004; Li & Huang, 2013).

Generous praise vs. limited praise

Across several studies, Chinese and U.S. teachers appear to hold differing beliefs on how teachers should praise students (Bear et al., 2016; Li et al., 2018; Wang et al., 2019). Chinese teachers believe that a good teacher should not be overly generous with praise to maintain high standards. This view is consistent with a popular Chinese idiom: "A strict teacher produces outstanding students" (Li et al., 2018). American teachers, on the other hand, tend to use praise as a way to encourage students and spark greater student engagement (Cai & Wang, 2010, Li et al., 2018). The American tendency towards praise may be due to popular learning theories such as theories of self-efficacy and growth mindset theory, both of which have heavily influenced U.S. teacher education programs (Wang et al., 2017).

Less-structured vs. highly-structured lessons

Chinese teachers tend to prefer *highly structured lessons* with more activities (Li et al., 2018). For Chinese teachers, a good lesson has a coherent structure with a strong connection of mathematical ideas throughout all activities (An et al., 2006; Cai & Wang, 2010; Correa et al., 2008; Li et al., 2018). On the other hand, U.S. teachers prefer shorter lessons with less seatwork (Li et al., 2019; Correa et al., 2008). They are more open to *less-structured lessons* that allow for spontaneous discussions (Li et al., 2019; Cai & Wang, 2010).

Concrete representations vs. abstract representations

Chinese and U.S. teachers prefer different strategies for developing students' mathematical understanding, with Chinese teachers emphasizing *abstraction* while U.S. teachers emphasizing *concrete* experiences. Chinese teachers emphasize students' mathematical understanding by connecting abstract knowledge pieces. Chinese teachers tend to emphasize abstract reasoning over hands-on activities (Bryan et al., 2007). U.S. teachers tend to emphasize

mathematical understanding by providing concrete manipulatives and more in-class group activities (Cai & Wang, 2010; An et al., 2006).

Child-centered vs. teacher-directed

Historically, researchers have pointed to a clear "cultural distinction" between Western and East Asian educators' beliefs about teaching and learning. Researchers have concluded that Western educators hold more child-centered, pedagogical views whereas East Asian educators hold more teacher-directed beliefs (Jablonka & Keitel, 2006; Perry et al., 1999; 1997). Several studies supported this dichotomy, which reported that Chinese teachers tend to have more of a teacher-led view of classroom instruction than U.S. teachers, who tend to hold more student-centered views (Cai & Wang, 2010; An et al., 2006; Bredekamp, 2004). More recent studies of Chinese teachers' beliefs paint a different picture. Several studies found that Chinese mathematics teachers tend to hold more constructivist beliefs about teaching and learning (Wang et al., 2022; Yang et al., 2020; Zhu et al., 2021).

Summary and Critique

Past research has characterized Western and East Asian educational approaches to be distinctly different. Leung's (2001) *Features of East Asian Mathematics Education* framework organized "Western" and "Eastern" pedagogy along six cultural dichotomies. Using Leung's framework as a starting point for identifying cultural variation, I reviewed cross-cultural studies of teachers' beliefs to identify overarching cultural differences between U.S. and Chinese teachers' pedagogical beliefs. The literature review suggests that American and Chinese teachers do hold distinct beliefs about mathematics education (Correa et al., 2008; Tobin et al., 2009; Yang et al, 2020; Li et al., 2018). Moreover, this review identified three additional dichotomies related to teachers' beliefs about teaching methods, teacher praise, and lesson structure.

Together, these findings suggest that U.S. and Chinese teachers' pedagogical beliefs may differ along 10 dimensions: 1) evaluation; 2) learning process; 3) teaching method; 4) teacher expertise; 5) teacher praise; 6) class structure; 7) lesson structure; 8) motivation; 9) rote learning; 10) conceptual understanding.

A major issue for this area of research is the limited empirical evidence to support these cultural dichotomies. Few studies have directly assessed and systematically examined whether these "Western" and "Eastern" features accurately represent what teachers from these countries believe about teaching and learning. In fact, more recent studies of Chinese teachers' pedagogical beliefs actually contradict "Eastern" stereotypes (Wang et al., 2022; Yang et al., 2020; Zhu et al., 2021). For example, several studies reported that Chinese mathematics teachers' pedagogical beliefs are more constructivist than instructivist (Wang et al., 2022; Yang et al., 2020; Zhu et al., 2021). These insights contradict "Eastern" stereotypical pedagogical features (SPFs) such as *teacher-directedness*, *product-oriented*, and *rote learning*. Likewise, some studies of U.S. teachers' beliefs have reported that American teachers held more instructivist views about mathematics (Stipek et al., 2001; Sunwoo, 2014), especially compared to other Western European countries such as Norway, Germany, and Switzerland (Felbrich et al., 2012). While the majority of these studies did report cross-cultural differences that appear to correspond with "Western" and "Eastern" stereotypes, these findings support only some of the six dichotomies presented in Leung's (2001) framework. Due to the limited and contradictory empirical evidence, I argue that these binary characterizations of "Western" and "Eastern" pedagogy should be reframed as cultural stereotypes– stereotypical pedagogical features (SPF)– rather than established cultural features.

A secondary issue is that we need a more rigorous approach to understanding the influence of culture on what teachers believe. In cross-cultural research of teachers' beliefs, typically, U.S. and Chinese teachers are asked to describe their views on teaching and learning through surveys or interviews. Pedagogical features, practices, and values identified across teachers' responses are then described as cultural beliefs. Whether these views reflect cultural pedagogical beliefs— as opposed to personal beliefs– remains unclear. To my knowledge, no cross-cultural studies of teachers' beliefs directly asked teachers to describe and reflect on cultural norms and values. This is important because what teachers personally believe about teaching may be different from the cultural norm and values.

To address these issues, the proposed study will 1) apply a pre-determined typology of "Western" and "Eastern" stereotypical pedagogical features (SPFs) to analyze teachers' beliefs and (2) independently assess teachers' pedagogical beliefs (T-PB) and their perceptions of their culture's pedagogical beliefs (TP-CPB) about mathematics education. This will allow me to examine individual and group variations in teachers' pedagogical beliefs as well as to investigate the accuracy of "Western" and "Eastern" stereotypes in describing U.S. and Chinese teachers' beliefs.

Research Questions

In order to better understand Western and East Asian educators' views on mathematics education, we first need to independently assess for the influence of culture on teachers' beliefs. Previous studies of teachers' beliefs did not distinguish between teachers' personal views and their perceptions of their culture's views on teaching and learning. To address this gap, RQ1 seeks to understand U.S. and Chinese teachers' *personal* pedagogical beliefs (T-PB). Because China has adopted student-centered pedagogical reforms in recent years (Tan, 2017), it is likely

that both Chinese and U.S. teachers' pedagogical beliefs (T-PB) should be more aligned with "Western" features (H1). Typically, differences in teacher practice and knowledge are attributed to underlying cultural beliefs (Fang, 1996; Hu et al., 2017; Yang et al., 2020). But few studies include the perspectives of cultural insiders to support the researchers' claims about cultural values, norms, and traditions. RQ2 centers the voices of cultural insiders by exploring U.S. and Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB). Given previous findings that suggest teachers' beliefs seem to correspond, at least to some extent, to stereotypes found in the literature, these U.S. and Chinese teachers should agree that stereotypical pedagogical features characterize their respective cultures (H2).

Secondly, we need to address the possibility that stereotypical characterizations of "Western" and "Eastern" pedagogy may no longer accurately represent current perspectives on mathematics education in the U.S. and China. Researchers often rely on stereotypically "Western" or "Eastern" pedagogical features (SPFs) when interpreting group differences in U.S. and Chinese teachers' beliefs. This is because U.S. and China are often held up as exemplars of "Western" and "Eastern" values, traditions, and philosophies (Leung et al., 2013; Marginson & Yang, 2021; Zhao, 2005). Yet, both countries have experienced political, economic, and societal changes in their educational system in recent years (Marginson & Yang, 2021) These changes may signal a shift away from traditional "Western" and "Eastern" pedagogical features towards a "global" model of education (Sahlberg, 2016). Given these changes, U.S. and Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) should match more closely to stereotypical pedagogical features (SPFs) than their own pedagogical beliefs (T-PB), which may be more influenced by recent educational reforms and policies (H3).

Therefore, the research questions are:

RQ1: What are U.S. and Chinese teachers' pedagogical beliefs (T-PB) about mathematics education?

Hypothesis 1. When asked, "To what extent do you agree/disagree with the following statements about the nature of mathematics," these U.S. and Chinese teachers' pedagogical beliefs (T-PB) should agree more with "Western" stereotypical pedagogical features.

RQ2: What are U.S. and Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) about mathematics education?

Hypothesis 2. When asked, "To what extent does each statement characterize your culture's views on teaching and learning," these U.S. and Chinese teachers should agree that stereotypical pedagogical features (SPFs) characterize their respective cultures.

RQ3: How do teachers' pedagogical beliefs (T-PB) compare against stereotypical pedagogical features (SPF)? How do teachers' perceptions of cultural pedagogical beliefs (TP-CPB) compare against stereotypical pedagogical features (SPF)?

Hypothesis 3. When comparing the level of match between teachers' beliefs and stereotypical pedagogical features (SPFs), teachers' perceptions of cultural pedagogical beliefs (TP-CPB) should align more with stereotypical pedagogical features (SPFs) than their pedagogical beliefs (T-PB).

Conceptual Framework

The conceptual framework is organized around three central constructs: teachers' pedagogical beliefs (T-PB), teachers' perceptions of cultural pedagogical beliefs (TP-CPB), and stereotypical pedagogical features (SPFs). I first clarify and define the meanings of these key constructs. Then, I present and describe the *Western and East Asian Features of Mathematics Education* as an analytic framework to assess the extent to which teachers' beliefs align with "Western" or "Eastern" features.

Teacher's Pedagogical Beliefs (T-PB)

In mathematics education, teachers' pedagogical beliefs have been described as' "conscious or subconscious beliefs, concepts, meanings, rules, mental images, and preference concerning the discipline of mathematics" (Thompson 1992, p. 132). In this study, teacher's pedagogical beliefs (T-PB) are defined as participants' understanding about the nature of mathematics and the kinds of knowledge that are important for mathematics and participants' expectations for the role of teachers and students in a math class. These beliefs may be distinct from what the teacher perceives as their culture's pedagogical beliefs (TP-CPB) about teaching and learning.

Teacher's Perception of Cultural Pedagogical Beliefs (TP-CPB).

Teacher's Perception of Cultural Pedagogical Beliefs (TP-CPB) refers to teachers' perceptions of their culture's views about the nature of mathematics and how it should be taught as well as the cultural expectations of teachers and students.

Stereotypical Pedagogical Features (SPFs)

Stereotypical pedagogical features (SPFs) are defined as the set of beliefs and values typically associated with "Western" or "East Asian" approaches to teaching and learning mathematics.

Western and East Asian Features of Mathematics Education Analytic Framework

The *Western and East Asian Features of Mathematics Education* framework (adapted from Leung, 2001) was generated through prior theory, research, and pilot study data. This framework identifies 20 stereotypical pedagogical features (SPFs): 10 "Western" features and 10 "Eastern" features (Table 1.1). This framework organizes these SPFs along 10 dimensions: (1) *evaluation*; (2) *learning process*; (3) *teaching method*; (4) *teacher expertise*; (5) *teacher praise;* (6) *class structure;* (7) *lesson structure;* (8) *motivation*; (9) *rote learning*; (10) *conceptual understanding*.

Table 1.1 Western and East Asian Features of Mathematics Education

Dimension	Western Perspective	East Asian Perspective
Evaluation	Process-oriented: tendency to emphasize the process of doing mathematics	Product-oriented: tendency to emphasize mathematical knowledge and skills
Learning Process	Pleasurable learning: tendency to believe that learning should be meaningful and enjoyable	Studying hard: tendency to see studying as a serious endeavor which requires hard work and perseverance
Teaching Method	Child-centered: tendency to see teaching as the facilitation of students' process of inquiry	Teacher-directed: tendency to see teaching as the transmission of knowledge from the teacher to the students
Teacher Expertise	General pedagogical knowledge: tendency to see the role of the teacher as a facilitator with profound pedagogical competencies	Subject matter knowledge: tendency to see the role of the teacher as a scholar with profound subject-matter knowledge
Teacher Praise	Generous praise: tendency to praise students at all ability levels	Limited praise: tendency to praise exceptional student work or performance
Class Structure	Individualized learning: tendency to see teaching and learning as individualized process with the student at the center	Whole class teaching: tendency to see teaching and learning as a collective activity with the teacher at the center

Method

This study used a combination of survey and interview methods to examine the extent to which U.S. and Chinese teachers' self-reported beliefs agree with "Western" or "Eastern" stereotypical pedagogical features (SPFs). Teachers' pedagogical beliefs (T-PB) and perceptions

of cultural pedagogical beliefs (TP-CPB) will be captured through surveys (*Cultural and Personal Views on Mathematics Education Survey*) and semi-structured interviews. These responses will then be analyzed using the *Western and East Asian Features of Mathematics Education* framework to determine the extent to which teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) agree with the stereotypical pedagogical features (SPFs) identified in this typology.

Participants

Twelve middle school mathematics participants from U.S. (N = 6) and mainland China (N = 6) were recruited to participate in this study. The participants were selected according to a criterion-based sampling strategy to fulfill the study's purpose (Hatch, 2002). Participants were recruited based on the following criteria: (1) licensed teacher; (2) have had at least two years of experience teaching mathematics at a middle school level (grades 7-9); (3) native-born U.S. citizen or native-born citizen of mainland China. Chinese teachers were recruited from two different schools in Nanjing, a large city in Jiangsu province. U.S. teachers were selected from three states: Michigan, Ohio, and Texas. Four teachers (2 U.S. and 2 Chinese) held a bachelor's degree while seven teachers (3 U.S. and 4 Chinese) held a master's degree. One U.S. teacher held a Doctorate degree. Both U.S. and Chinese teachers held an average of 7 years of mathematics teaching experience. The average age of the U.S. teachers was 31 years old, and the average of the Chinese teachers was 30 years old.

Data Sources

Cultural and Personal Views on Mathematics Education Survey

Teachers' perceptions of cultural pedagogical beliefs (TP-CPB) and pedagogical beliefs (T-PB) were assessed using a 40-item survey generated from the *Western and East Asian Features of Mathematics Education* framework (items adapted from Leung, 2001 and *TEDS-M*).

Participants were presented with a list of 40 belief statements that reflected "Western" or "Eastern" cultural stereotypes about teaching and learning. To determine teachers' pedagogical beliefs (T-PB), participants indicated the extent to which they personally agreed or disagreed with each statement. To determine teachers' perceptions of the culture's pedagogical beliefs (TP-CPB), participants indicated the extent to which each statement agreed or disagreed with their culture's approach to teaching and learning.

Semi-Structured Interviews

Participants completed 60-minute interviews. The interviews follow a semi-structured format, which involves the use of predetermined interview questions which are pursued in a conversational manner that allows participants to the chance to explore additional issues and insights (Newcomer et al., 2015; Fylan, 2005). The interview protocol included eight structured open-ended questions. Structured interview questions are questions developed with the predetermined thematic framework in mind (Fylan, 2005). For instance, the first four questions addressed teachers' pedagogical beliefs (T-PB). Teachers were asked to describe their philosophies about teaching and learning as well as their personal expectations for teachers and students. Open-ended questions refer to nature of the question: open-ended questions elicit longer responses in comparison to close-ended, which can generally be answered by a single-word response (e.g., yes/no questions). The second set of four questions asked teachers to describe their perceptions of their culture's pedagogical beliefs (TP-CPB). In addition to the structured questions, each participant responded to two to four individualized questions which emerged spontaneously through the conversations. These questions explored the participant's perceptions of the tensions between their personal views and broader cultural expectations about teaching and learning.

Data analysis

Personal and Cultural Beliefs Survey

Teachers (N = 12) were presented with a list of 40 belief statements representing 20 stereotypical pedagogical features (10 "Western" features and 10 "Eastern" features). Teachers rated their level of agreement or disagreement with each statement on a 4-point Likert scale ("0 = strongly disagree, 1 = somewhat disagree, 2 = somewhat agree, 3 = strongly agree"). Teachers' level of agreement with each SPF was calculated using a composite score combining the two survey items. Data analysis consisted of descriptive statistics (means, standard deviations, differences) for both T-PB and TP-CPB survey ratings. The statistical analysis centered around comparison of group means because the variation in the participants' responses was not large enough to warrant other measures. I then compared group differences between US and Chinese teachers' level of agreement for each stereotypical pedagogical feature (SPF). Stereotypical pedagogical features (SPFs) with an average group rating of 2.5 ("strongly agree") or higher are identified in the results.

Semi-structured interviews

Interview data were coded in two steps. The first coding step sorted teachers' statements into pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB). I first read the transcripts in their entirety and then highlighted passages in which teachers discussed: (a) personal expectations, beliefs, preferences, or norms about teaching and learning mathematics (T-PB) and (b) cultural expectations, beliefs, preferences, or norms about teaching and learning mathematics (TP-CPB). I then tabulated the number of instances a teacher made a statement describing their personal pedagogical beliefs (T-PB) and their perceptions of their culture's pedagogical beliefs (TP-CPB). I identified 231 T-PB statements and 92 TP-CPB statements.

An a priori coding framework was developed to identify belief statements related to each of the 20 stereotypical pedagogical features (SPFs) from the *Western and East Asian Features of Mathematics Education* framework. The coding system includes 20 items grouped across 10 categories. I then applied the *Western and East Asian Features of Mathematics Education* framework to categorize the coded T-PB and TP-CPB according to this list of features. To accomplish this, I reviewed each coded T-PB and TP-CPB statement and added a code for a SPF when a participant described or discussed something that reflect a particular feature. In total, 224 T-PB statements and 52 TP-CPB statements were assigned SPF sub-codes. 47 coded statements (7 T-PB and 40 TP-CPB) were categorized as "Other" because they did not relate to any of the features identified in the predetermined framework. I reviewed and organized these 47 statements to look for thematic similarities or differences. From this process, I identified seven additional themes which emerged from the data.

To increase the trustworthiness of the data analysis for the coded features, I presented two independent raters with the coding scheme which includes definitions and samples for all features. I met with each rater individually to discuss the rating process. I selected 30% (83 statements) of the total coded SPF statements (276 statements) for the raters to code independently. Both raters were PhD students with teaching experience and research interests in mathematics education and teacher noticing.

Using the qualitative software MAXQDA, three researchers independently coded teachers' beliefs statements according to each SPF. We initially agreed on 64 out of 83 coded statements, or 77%. I made clarifications to the definition of two features (*abstract representations* and *general pedagogical knowledge*) and asked the raters to re-code according to the revised definitions. This resolved 7 discrepancies, raising the level of agreement to 86%.

After two rounds of coding, inter-rater reliability was established at 0.86 overall, with a range of 0.71–1.00 for individual SPF codes. Coded SPF statements are listed in order of frequency for teachers' pedagogical beliefs (T-PB) and teachers' perceptions of cultural pedagogical beliefs (TP-CPB). Finally, I compared the frequency and proportion of each SPF statement mentioned by U.S. and Chinese teachers.

Findings

RQ1. What are U.S. and Chinese teachers' pedagogical beliefs (T-PB) about mathematics education?

When asked to rate and describe their personal beliefs on teaching and learning mathematics, it was expected that both Chinese and U.S. teachers' pedagogical beliefs (T-PB) would agree more with "Western" features than "Eastern" features (H1). Overall, the survey and interview data provide broad support for H1. Quantitative results from the survey show that both U.S. and Chinese teachers' (N=12) pedagogical beliefs (T-PB) showed higher agreement with "Western" features ($M_{U.S.}$= 2.3, M_{CH} = 2.5) than on "Eastern" features ($M_{U.S.}$= 1.8, M_{CH} = 2.1) (Table 2). See for means and standard deviations. Qualitative data from interview data were generally consistent with quantitative survey results. U.S. teachers' pedagogical belief (T-PB) statements from interview data mentioned "Western" features (N= 77 statements, 69%) more frequently than "Eastern" features (N = 29 statements, 26%). The Chinese teachers' pedagogical belief (T-PB) statements were somewhat split between "Western" and "Eastern" features, with a slight majority of the coded statements expressing a preference for "Western" features (N = 66 statements, 55%) over "Eastern" features (N = 52 statements, 44%).

Quantitative findings: U.S. and Chinese T-PB ratings

Teachers (N = 12) were presented with a list of 40 belief statements representing 20 stereotypical pedagogical features (10 "Western" and 10 "East Asian" features). Overall, the U.S. teachers' pedagogical beliefs (T-PB) averaged 2.3 for Western features and 1.8 for Eastern features. The difference between U.S. teachers' agreement with Western and Asian features was 0.5. Strong agreement ($M \geq 2.5$) was found for three of the ten "Western" features: *less-structured lessons ($M_{U.S.} = 2.7$), individualized learning ($M_{U.S.} = 2.7$),* and *child-centeredness ($M_{U.S.} = 2.5$).*

The Chinese teachers' pedagogical beliefs (T-PB) averaged 2.5 for Western features and 2.1 for Eastern features. The difference between their agreement with Western and Asian features was 0.4. Strong agreement ($M \geq 2.5$) was found for five of the 10 "Western" features: *child-centeredness* ($M_{CH} = 2.8$), *process orientation* ($M_{CH} = 2.8$), *intrinsic motivation* ($M_{CH} = 2.8$), *memorizing to reinforce* ($M_{CH} = 2.8$), and *concrete representation* ($M_{CH} = 2.8$). The Chinese teachers reported strong agreement ($M \geq 2.5$) for two of the 10 "Eastern" features: *studying hard* ($M_{CH} = 2.8$), and *abstract representation* ($M_{CH} = 2.8$).

Table 1.2 U.S. and Chinese teachers' pedagogical beliefs (T-PB) average survey scores

To what extent do you agree/disagree with the following statements about the nature of mathematics?

(0= Strongly disagree, 1= Somewhat disagree, 2= Somewhat agree, 3= Strongly agree)

*** M = n ≥ 2.5**

Blue= "Western" Feature

Red= "East Asian" Feature

Dimension	SPF	U.S. Mean	Chinese Mean	Mean Difference
Evaluation	**Process**	2.3	**2.8***	-0.5
	Product	1.8	**2.6***	-0.8
Teacher Expertise	**General Pedagogical Knowledge**	2.3	2.3	0.0
	Subject Matter Knowledge	1.1	1.8	-0.7
Teaching Method	**Child-centered**	**2.5***	**2.8***	-0.3
	Teacher-directed	2.3	2.3	0.0
Lesson Structure	**Less-Structured**	**2.7***	2.0	0.7
	Highly Structured	1.4	2.3	-0.9
Teacher Praise	**Generous Praise**	2.0	2.4	-0.4
	Limited Praise	1.4	1.3	0.1
Rote Learning	**Memorizing to Reinforce**	2.2	**2.8***	-0.6
	Memorizing to Understand	1.3	1.4	-0.1
Motivation	**Intrinsic**	2.1	**2.8***	-0.7
	Extrinsic	2.3	2.2	0.1
Class Structure	**Individualized Learning**	**2.7***	1.5	1.2
	Whole Class	1.7	2.3	-0.6
Learning Process	**Pleasurable Learning**	2.1	2.3	-0.2
	Studying Hard	2.2	2.0	0.2
Conceptual Understanding	**Concrete Representation**	2.3	**2.8***	-0.5
	Abstract Representation	2.4	**2.8***	-0.4
	Average of Western Features	2.3	2.5	-0.2
	Average of Eastern Features	1.8	2.1	-0.3
	Difference	0.5	0.4	

Qualitative findings: U.S. and Chinese teachers' descriptions of pedagogical beliefs (T-PB)

Teachers were asked to describe their personal teaching philosophies and beliefs about teaching and learning mathematics. We identified and coded 112 unique statements about U.S. teachers' pedagogical beliefs (T-PB) using open-ended questionnaire responses and interviews. Coded features are organized by frequency of statements (no. of statements, % of total statements) and frequency of occurrence amongst participants who expressed statements related to each code (no. of teachers, % of total teachers). As a whole, U.S. teachers most frequently made statements related to the following features: *process-orientation* (12 statements, 11%), *child-centered* instruction (11 statements, 10%), and *pleasurable learning* (11 statements, 10%). However, it is important to note that most frequently coded SPFs are not necessarily the most commonly referenced SPFs amongst all participants. For instance, there were 11 statements related to *child-centeredness* made by four out of six U.S. teachers. In contrast, certain SPFs were expressed in fewer statements but were mentioned by almost every participant. The SPFs that were most commonly mentioned by the U.S. teachers were: *process-orientation* (N = 6, 100%), *general pedagogical knowledge* (N = 5, 83%), *less-structured lessons* (N = 5, 83%), *concrete representation* (N = 5, 83%), *individualized learning* (N = 5, 83%), and *extrinsic motivation* (N = 5, 83%).

Chinese teachers made 119 unique statements describing their pedagogical beliefs (T-PB). Chinese teachers most frequently made statements related to the following features: *child-centered* instruction (16 statements, 13%), *teacher-directed* instruction (12 statements, 10%), and *process-orientation* (11 statements, 10%). However, as with the U.S. teachers, the features with the highest number of coded statements are different from the features that were most widely discussed amongst the Chinese participants (N = 6). The SPFs that were most commonly

mentioned by the Chinese teachers were: *teacher-directedness* (N = 6, 100%), *subject matter knowledge* (N = 6, 100%), *general pedagogical knowledge* (N = 6, 100%), and *product-oriented* (N = 6, 83%).

RQ2. What are U.S. and Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB) about mathematics education?

To determine teachers' perception of their culture's pedagogical beliefs (TP-CPB), participants were presented with a list of 40 belief statements consisting of 20 "Western" and 20 "Eastern" pedagogical stereotypes. When asked, "To what extent does each statement characterize your culture's views on teaching and learning," U.S. teachers should agree more with "Western" stereotypes; Chinese teachers should agree more with "Eastern" stereotypes (H2). However, U.S. TP-CPB ratings did not agree with "Western" stereotypical pedagogical features (SPFs) as expected. U.S. teachers' perception of their culture's beliefs (TP-CPB) about mathematics pedagogy were a mix of "Western" and "Eastern" features while the Chinese TP-CPB showed strong agreement ($M_{CH} = 2.5$) with "Eastern" features (Table 3). The survey data was consistent with the interview data. When asked to describe their perceptions of their culture's pedagogical beliefs (TP-CPB), U.S. teachers made a similar number of statements (N= 40) related to both "Western" (13 statements, 32% of codes) and "Eastern" features (10 statements, 25% of codes). The majority of the Chinese teachers' TP-CPB statements (N= 59) referred to "Eastern" features (23 statements, 39% of codes) over "Western" features (13 statements, 22% of codes).

Quantitative findings: U.S. and Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB)

U.S. teachers' perceptions of cultural pedagogical beliefs (TP-CPB) did not show strong agreement ($M \geq 2.5$) with any "Western" features. When rating their perceptions of their culture's pedagogical beliefs (TP-CPB), U.S. teachers somewhat agreed ($2.2 < M < 2.5$) with five out of 10 "Western" features: *less-structured* lessons ($M_{U.S.}= 2.3$), *generous praise* ($M_{U.S.} = 2.3$), *individualized learning* ($M_{U.S.} = 2.3$), *pleasurable learning* ($M_{U.S.} = 2.3$), and *concrete representation* ($M_{U.S.} = 2.4$). It is striking to note U.S. teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) about *Rote Learning*: U.S. teachers somewhat disagreed ($1.0 \leq M < 1.5$) with the "Western" feature of *memorizing to reinforce* ($M_{U.S.}=1.3$), but strongly agreed ($M \geq 2.5$) with the "Eastern" feature of *memorizing to understand* ($M_{U.S.}=2.5$).

Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) showed strong agreement for five out of 10 "Eastern" features: *product-orientation* ($M_{CH} = 2.5$), *subject matter knowledge* ($M_{CH} = 2.6$), *highly-structured* lessons ($M_{CH} = 2.8$), *studying hard* ($M_{CH} = 2.8$), and *abstract representations* ($M_{CH} = 2.8$). One out of 10 "Western" features somewhat disagreed with Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB): *less-structured* lessons ($M_{CH} = 1.4$). Surprisingly, Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) also showed strong agreement with four out of 10 "Western" features: *process-orientation* ($M_{CH} = 2.8$), *intrinsic motivation* ($M_{CH} = 2.5$), *pleasurable learning* ($M_{CH} = 2.8$), and *concrete representation* ($M_{CH} = 2.9$).

Qualitative findings: U.S. and Chinese teachers' descriptions of perceived cultural pedagogical beliefs (TP-CPB)

U.S. teachers made 40 statements about their perceptions of cultural pedagogical beliefs (TP-CPB) in their interview transcripts and open-ended responses. The most frequently and widely mentioned "Western" features are: *child-centered teaching* (4 statements, 67% of teachers), *less-structured lessons* (4 statements, 67% of teachers), and *individualized learning* (3 statements, 50% of teachers). In contrast, the most frequently and widely mentioned "Eastern" features were mentioned by only two U.S. teachers: *product orientation* (2 statements, 33% of teachers), *teacher-directedness* (2 statements, 33% of teachers), and *memorizing to understand* (2 statements, 33% of teachers), and *studying hard* (2 statements, 33% of teachers).

13 statements were coded under "Other". The following additional themes were identified across these statements: *collaborative learning* (6 statements, 100% of teachers), *shallow learning* (4 statements, 33% of teachers), *hatred of mathematics* (4 statements, 67%), and *school as childcare* (3 statements, 50% of teachers).

59 TP-CPB statements were coded across Chinese teachers' interview transcripts and open-ended responses. The most frequently coded and commonly referenced "East Asian" features are: *teacher-directed* (4 statements, 67% of teachers), *extrinsic motivation* (4 statements, 67% of teachers), *product-orientation* (3 statements, 50% of teachers), and *whole class teaching* (3 statements, 50% of teachers). An unexpected finding was that the most of these Chinese teachers also perceived their culture's pedagogical beliefs (TP-CPB) to be *child-centered* (5 statements, 83% of teachers). 17 TP-CPB statements were coded under "Other". The following additional themes were identified across these statements: *mathematics is highly valued* (6

statements, 100% of teachers), *teacher-directed small group activities* (12 statements, 100% of teachers), and *complex problem solving* (5 statements, 83% of teachers).

RQ3. How do teachers' pedagogical beliefs (T-PB) compare against stereotypical pedagogical features (SPF)? How do teachers' perceptions of cultural pedagogical beliefs (TP-CPB) compare against stereotypical pedagogical features (SPF)?

When comparing U.S. and Chinese teachers' T-PB and TP-CPB, it was expected that these teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) should match more closely to stereotypical pedagogical features (SPFs) than their pedagogical beliefs (T-PB) (H3). Specifically, U.S. teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) should agree more with "Western" features than their own pedagogical beliefs (T-PB); likewise, Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) should agree more with "Eastern" features than their personal pedagogical beliefs (T-PB). However, this hypothesis was not fully supported by the data. Although Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB) showed higher agreement for "East Asian" SPFs than their pedagogical beliefs (T-PB) *(*$M_{CH\text{-}TP\text{-}CPB}$= 2.5, $M_{CH\text{-}TPB}$= 2.1), the U.S. teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) did *not* show higher agreement on "Western" SPFs compared to their personal pedagogical beliefs (T-PB) *(*$M_{U.S.\text{-}TP\text{-}CPB}$= 2.0, $M_{U.S.\text{-}TPB}$= 2.3) (3.1).

The average scores for "Western" features were calculated by taking the combined average of teachers' pedagogical belief (T-PB) scores for all belief statements describing "Western" stereotypical pedagogical features (SPFs). This process was repeated for calculating the total average for "Eastern" features. The average scores for teachers' perceptions of cultural pedagogical beliefs (TP-CPB) were derived using the same process.

Table 1.3 Level of agreement with Western and East Asian SPFs in T-PB and TP-CPB (0 = strongly disagree, 1= somewhat disagree, 2 = somewhat agree, 3= highly agree)

Features	U.S. T-PB	U.S. TP-CPB	Chinese T-PB	Chinese TP-CPB
Western	*M* = 2.3, *SD* = 0.2	*M* = 2.0, *SD* = 0.3	*M* = 2.5, *SD* = 0.4	*M* = 2.1, *SD* = 0.3
East Asian	*M* = 1.8, *SD* = 0.5	*M* = 2.1, *SD* = 0.4	*M* = 2.1, *SD* = 0.5	*M* = 2.5, *SD* = 0.6
Mean Difference	0.5	-0.1	0.4	-0.4

Quantitative findings: how do teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) compare against SPFs?

U.S. teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) showed lower agreement with "Western" features than their personal pedagogical beliefs (T-PB) scores ($M_{U.S.-TPCB}$= 2.0, $M_{U.S.-TPB}$= 2.3). This contradicts the hypothesis (H3) that teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) should match more closely to their respective cultural stereotypes. The difference between U.S. teachers' T-PB and TP-CPB scores for "Western" features was 0.3. Specifically, U.S. teachers' pedagogical beliefs (T-PB) T-PB showed higher agreement (MD > 0.1) for five out of 10 "Western" features: *process-orientation* ($M_{U.S.T-PB}$ = 2.3, $M_{U.S.TP-CPB}$ =1.6*), general pedagogical knowledge* ($M_{U.S.T-PB}$ = 2.3, $M_{U.S.TP-CPB}$ =1.8), *child-centeredness* ($M_{U.S.T-PB}$ = 2.5, $M_{U.S.TP-CPB}$ =1.9), and *memorizing to reinforce* ($M_{U.S.T-PB}$ = 2.2, $M_{U.S.TP-CPB}$ =1.3). In contrast, U.S. teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) showed higher agreement for only two out of 10 "Western" features: *generous praise* ($M_{U.S.T-PB}$ = 2.0, $M_{U.S.TP-CPB}$ =2.3) and *pleasurable learning* ($M_{U.S.T-PB}$ = 2.1, $M_{U.S.TP-CPB}$ =2.3). U.S. T-PB and TP-CPB showed similar levels of agreement (MD ≤ 0.1) for two out of 10

"Western" features: *intrinsic motivation* ($M_{U.S.T\text{-}PB}$ = 2.1, $M_{U.S.TP\text{-}CPB}$ =2.0) and *concrete representation* ($M_{U.S.T\text{-}PB}$ = 2.3, $M_{U.S.TP\text{-}CPB}$ =2.4). These findings suggest that the American teachers consider their personal pedagogical beliefs (T-PB) to be more "Western" than their perceptions of their culture's pedagogical beliefs (TP-CPB).

In line with H3, these Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) were more in agreement with "Eastern" stereotypes than their own pedagogical beliefs (T-PB) ($M_{CH\text{-}TPCB}$= 2.5, $M_{CH\text{-}TPB}$= 2.1). The difference between Chinese teachers' T-PB and TP-CPB scores for "Eastern" features was -0.4. Chinese TP-CPB showed higher agreement (MD > 0.1) for five out of 10 "Eastern" SPFs: subject matter knowledge ($M_{CHT\text{-}PB}$ = 1.8, $M_{CHTP\text{-}CPB}$ = 2.6), highly structured lessons ($M_{CHT\text{-}PB}$ = 2.3, $M_{CHTP\text{-}CPB}$ =2.8), memorizing to understand ($M_{CHT\text{-}PB}$ = 1.4, $M_{CHTP\text{-}CPB}$ = 2.0), extrinsic motivation ($M_{CHT\text{-}PB}$ = 2.2, $M_{CHTP\text{-}CPB}$ =2.4), and studying hard ($M_{CHT\text{-}PB}$ = 2.0, $M_{CHTP\text{-}CPB}$ = 2.8). Chinese T-PB and TP-CPB showed similar levels of agreement (MD ≤ 0.1) for five out of 10 "Eastern" features: product-orientation ($M_{CHT\text{-}PB}$ = 2.6, $M_{CHTP\text{-}CPB}$ = 2.5), teacher-directedness ($M_{CHT\text{-}PB}$ = 2.3, $M_{CHTP\text{-}CPB}$ = 2.4), limited praise ($M_{CHT\text{-}PB}$ = 1.3, $M_{CHTP\text{-}CPB}$ = 2.4), whole class teaching ($M_{CHT\text{-}PB}$ = 2.3, $M_{CHTP\text{-}CPB}$ =2.3), and abstract representation ($M_{CHT\text{-}PB}$ = 2.8, $M_{CHTP\text{-}CPB}$ = 2.8). Together, these findings suggest that the Chinese teachers perceive their culture's pedagogical beliefs (TP-CPB) to match more closely with "Eastern" stereotypes whereas their personal pedagogical beliefs (T-PB) are more "Westernized".

Qualitative findings: tensions between teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (T-PB) create barriers to student-centered pedagogy

Comparisons of U.S. and Chinese T-PB and TP-CPB scores suggest that both groups consider their personal views on teaching and learning more "Westernized" than their culture's views, which are more aligned with "Eastern" pedagogy. To examine the underlying reasons for this pattern, we turn to the qualitative analyses of the interview and open-ended questions. In analyzing the semi-structured interviews and open-ended survey responses, U.S. and Chinese teachers made 316 unique coded statements about their pedagogical beliefs (T-PB) and perceptions of the cultural pedagogical beliefs (TP-CPB). Of these 316 statements, 265 statements (84%) referred to specific differences between teachers' pedagogical beliefs (T-PB) and their perceptions of the cultural pedagogical beliefs (TP-CPB).

All 12 teachers (100%) described their personal teaching philosophies as being more student-centered compared to their culture's approach to teaching and learning mathematics. Despite all 12 teachers describing their pedagogical beliefs as student-centered, six teachers described their instructional practice as teacher-directed (3 U.S. teachers and 3 Chinese teachers). Moreover, all 12 teachers (100%) identified key tensions between their preferred way of teaching (student-centered) and larger cultural expectations and beliefs about mathematics education.

U.S. teachers' perceptions of cultural barriers to student-centered learning

6 U.S. teachers (100%) discussed broader cultural expectations and structures that conflicted with their personal teaching philosophies and beliefs. These points of tension hinder their ability to teach in ways that are consistent with student-centered pedagogy. U.S. teachers identified the following barriers to effective student-centered instruction: *students' lack of*

motivation (100%), *standardized testing* (67%), *lack of parental support* (83%), *lack of respect for teachers* (100%), *class sizes* (50%), and *socio-economic inequality* (67%).

Chinese teachers' perceptions of cultural barriers to student-centered learning

All 6 Chinese teachers (100%) discussed broader cultural expectations and structures that were in conflict with their personal teaching philosophies and beliefs. Chinese teachers identified the following barriers to student-centered learning : high-stakes examinations *(100%),* class sizes *(100%),* restrictions on extracurricular programs *(67%),* student passivity *(67%), and* socio-economic inequality *(50%).*

Discussion

This study compared current U.S. and Chinese mathematics teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) against stereotypically "Western" and "East Asian" features. In line with (H1), U.S. and Chinese teachers' pedagogical beliefs (T-PB) were both more "Westernized" due to the global shift towards student-centered pedagogy. For RQ2, it was expected that U.S. and Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB) would align with the stereotypical pedagogical features (SPFs) of their respective cultures (H2). That is, it was anticipated that U.S. TP-CPB would agree most strongly with Western SPFs while Chinese teachers' TP-CPB would show strong agreement with East Asian SPFs. However, the U.S. teachers' perceptions of cultural pedagogical beliefs (TP-CPB) did *not* conform to "Western" stereotypical pedagogical features (SPFs) as expected. Regarding RQ3, teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) was expected to match more closely to their respective stereotypical pedagogical features (SPFs) than their pedagogical beliefs (T-PB) (H3). However, the findings were mixed. While Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB) matched more closely to

"Eastern" features than their pedagogical beliefs (T-PB), the U.S. teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) scored *lower* on "Western" features compared to their pedagogical beliefs (T-PB).

Enduring cultural differences: confirmation for previous findings about Western and East Asian education

In comparing teachers' beliefs, U.S. and Chinese teachers appear to hold several views about teaching and learning that were consistent with their respective "Western" and "Eastern" cultural stereotypes. With regard to views on *Lesson Structure*, and *Class Structure*. U.S. and Chinese teachers' beliefs differed as expected along the "Western" and "Eastern" features (Tables 2 and 3). These differences were found across both groups' T-PB and TP-CPB ratings and were further supported by the qualitative data.

Lesson structure: less-structured vs. highly-structured

U.S. and Chinese teachers' views about *Lesson Structure* were consistent with previous findings that Western teachers prefer flexible lessons that encourage spontaneous discussions, whereas East Asian teachers prefer more structured lessons with strong conceptual connections and more mathematical content (Cai & Wang, 2010; Correa et al., 2008; An et al., 2004; Li et al., 2018). U.S. teachers showed considerably higher agreement with *less-structured* lessons ($M_{U.S.T-PB}$ = 2.7, $M_{U.S.TP-CPB}$ =2.3) compared to *highly-structured* lessons ($M_{U.S.T-PB}$ = 1.4, $M_{U.S.TP-CPB}$ =2.0). Conversely, the Chinese teachers favored *highly-structured* lessons (M_{CHT-PB} = 2.3, $M_{CHTP-CPB}$ =2.8) over less-structured lessons (M_{CHT-PB} = 2.0, $M_{CHTP-CPB}$ =1.4).

Class structure: individualized learning vs. whole class teaching

For the *Class Structure* dimension, U.S. teachers showed higher agreement with *individualized learning* ($M_{U.S.T-PB}$ = 2.7, $M_{U.S.TP-CPB}$ =2.3) over *whole class teaching* ($M_{U.S.T-PB}$ =

2.7, $M_{U.S.TP\text{-}CPB}$ =2.3). Conversely, Chinese teachers reported higher agreement with *whole class teaching* for both their T-PB and TP-CPB ratings. It is likely that this cultural distinction still holds true for both U.S. and Chinese due to persisting differences in class sizes between Western and East Asian countries. Our U.S. teachers reported class sizes between 20-35 students whereas our Chinese teachers reported class sizes between 40-60 students. This dichotomy will likely persist in the coming years due to the stark population differences between the U.S. and China. However, in light of China's drastically falling birth rates coupled with Chinese parents' growing demand for more personalized instruction (Li et al., 2020), it is possible that *individualized learning* could become the norm for future generations.

Challenging preconceptions about Western and East Asian approaches to mathematics education

This study reports on two key findings that challenge previous claims about Western and East Asian approaches to mathematics education. Specifically, these findings subvert long-held stereotypes about Western and East Asian views on *Rote Learning* and *Motivation*. These differences were found in the survey data and were further corroborated in the semi-structured interviews.

Rote learning: memorizing to reinforce vs. memorizing to understand

The Chinese teachers scored higher on the *memorizing to reinforce* feature and lower on *memorizing to understand* compared to U.S. teachers for both their T-PB and TP-CPB ratings (Tables 2 and 3). Moreover, in the interviews, 5 out of 6 Chinese teachers reported using rote learning only after students have engaged in some form of inquiry, whereas 3 U.S. teachers reported using rote learning as a primary instructional activity. This stands in contrast to previous findings that Western teachers prefer to use rote learning methods, such as skill and drill, as a way to reinforce students' conceptual understanding (*memorizing to reinforce*) whereas East Asian teachers believe that rote learning can precede conceptual understanding (*memorizing to understand*) (Cai & Wang, 2010; Leung, 2001).

One possible reason for these findings may be due to the educational reform efforts in the respective countries. Since 2001, national reform efforts in China have shifted away from rote learning towards problem-solving and conceptual understanding (Tan, 2017). The Chinese teachers in this study have confirmed that China's national educational reform efforts will continue to emphasize open-ended problems and conceptual understanding in mathematics. For example, CH6 described how college entrance examination questions are becoming increasingly complex and dynamic, testing for conceptual understanding rather than procedural knowledge. U.S. teachers have also discussed the impact of standardized testing on their instructional practices. Several teachers (U.S.1, U.S.2, and U.S.5) described using rote learning strategies such as repeated practice and drilling to prepare students for these tests.

Motivation: intrinsic motivation vs. extrinsic motivation

The Chinese teachers scored considerably higher on the *intrinsic motivation* and lower on *extrinsic motivation* compared to U.S. teachers for both their T-PB and TP-CPB ratings

(Tables 2 and 3). This finding is somewhat surprising given that the literature typically depicts Western education as more inclined towards *intrinsic motivation*, whereas East Asian education is more *extrinsically-oriented* (Leung, 2001; Watkins & Biggs, 1996; 2000). Leung argues that Western teachers "consider the best way of motivating students to learn and to study is through getting students interested in the mathematics they are studying" (Leung, 2001, p. 42). In contrast, East Asian teachers consider external factors such as exams and family expectations, to be powerful motivators for East Asian students. However, the findings from this study challenge both claims.

When asked to describe how they motivate their students to learn mathematics, both U.S. and Chinese teachers agreed on the importance of sparking students' intrinsic motivation for learning mathematics. However, they held different views on how to nurture student interest. U.S. teachers were far more pessimistic about the possibility of sparking students' intrinsic motivation for mathematics. Previous studies have reported that U.S. teachers tend to use hands-on learning, real-world connections, and discovery learning to spark students' interest and engagement (Correa et al., 2008; Cai & Wang, 2010). While 3 U.S. teachers did describe using such methods, they also reported that their students remained unengaged. These U.S. teachers described using positive reinforcement such as rewards (candy, parties, etc.), games, and strong social bonds to make learning more enjoyable for their students. In contrast, all six Chinese teachers reported that their students come into classrooms with high levels of motivation and a readiness to learn, which is in direct contrast to U.S. teachers' descriptions of their students' attitudes. In fact, only one Chinese teacher (CH4) mentioned using exams as a motivator whereas five teachers (CH1, CH2, CH3, CH5, and CH6) discussed using pedagogical strategies that

support intrinsic motivation, such as cultivating students' sense of mastery and presenting novel problems.

One explanation as to why these U.S. teachers were more *extrinsically-oriented* while the Chinese teachers are more *intrinsically-oriented* could be that mathematics is disliked by many Americans **(**Beilock & Maloney, 2015; Furner & Berman, 2003**)**. In contrast, mathematics is highly regarded in China, not purely for practical purposes but also from a deep appreciation of the beauty of mathematics (Correa et al., 2008; Cai & Wang, 2010; Cai, 2007; Seah, 2003; Li & Huang, 2013).There is an entire section in the Mathematics Curriculum Standards for Compulsory Education (MCSCE 2010) devoted to the aesthetic appreciation of mathematics ("Beauty and Mathematics") (Wang et al., 2017). It is much more difficult, if not impossible, to make the shift from amotivation to intrinsic motivation. Thus, U.S. educators may feel they need to rely on extrinsic motivators to make mathematics more palatable for reluctant learners. It is relatively easier for these Chinese teachers to motivate their students since most Chinese students consider mathematics essential for future success.

U.S. and Chinese teachers' perceived cultural barriers to enacting student-centered teaching

The findings on U.S. and Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) challenge the widely held assumption that American schooling culture is more conducive to student-centered learning compared to Chinese schooling. In fact, both U.S. and Chinese teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) were more "Eastern"-oriented compared to their personal pedagogical beliefs (T-PB), which were more "Western"-oriented. For instance, both groups reported higher agreement with "Western" features associated with student-centered pedagogy (i.e., *child-centeredness, less-structured*

lessons, and *memorizing to reinforce)* for their pedagogical beliefs (T-PB) compared to their perceptions of their culture's pedagogical beliefs (TP-CPB) (Tables 2 and 3). U.S. and Chinese teachers explored these differences in the interviews, in which both groups discussed the societal expectations, practices, and norms that present barriers to student-centered teaching.

The Chinese teachers described the difficulty of conducting small group activities and individualized learning with class sizes of 40-60 students. Additionally, Chinese teachers face a lot of pressure from parents and governmental authorities to ensure that they are preparing the students to do well on the exams. These pressures hinder Chinese teachers' willingness to be more experimental and innovative in their teaching practices. Despite their deeply held personal convictions about student-centered pedagogy, Chinese teachers swim against a cultural tide that has yet to make the necessary shifts to support student-centered teaching.

U.S. teachers also identified standardized testing and large classroom sizes as significant barriers to student-centered teaching. Although U.S. teachers' class sizes were considerably smaller (20-30 students) than the Chinese teachers' classes, it remains challenging for U.S. teachers to provide individualized instruction for their students. Like the Chinese teachers, U.S. teachers also face pressure to teach to the test. However, U.S. teachers do not have the same level of support and cooperation from students and parents as Chinese teachers. U.S. teachers have to deal with the additional challenge of working with unmotivated students who may not have the guidance and resources at home to support their learning. These factors, coupled with a culture of mathematics phobia, mean that student-centered pedagogy can be just as challenging for U.S. teachers.

Implications for practice

Ending the West vs. East Debate: Towards an integrative model of mathematics education

U.S. and Chinese educators may benefit from an integrative teaching and learning model that incorporates a blend of "Western" and "East Asian" features. Presenting "Western" and "East Asian" features as "either-or" dichotomies may constrain effective instructional methods, particularly for U.S. educators. Our findings also challenge the notion that "East Asian" features are incompatible with constructivist learning. Instead, many of these "East Asian" features can be used to complement "Western" features.

The "guided participation" model has been proposed as an alternative to student-centered learning (Rogoff, 1990, 1993; Mascolo, 2009). In this view, learning is neither student-centered nor teacher-centered; rather, learning is a collaborative process in which both students' and teachers' interactions are at the center of learning. Under this framework, teachers' guidance (e.g., lectures, scaffolding, questioning, directions) are organized to support students' participation in educational activities (e.g., small group discussions, group activities, independent work). This model combines both "Western" and "East Asian" features into a constructivist framework for teaching and learning.

Implications for research

Tensions between T-PB and TP-CPB can point to gap between teachers' beliefs and practice

This study used independent assessments of teachers' pedagogical beliefs (T-PB) and their perceptions of the cultural pedagogical beliefs (TP-CPB) to examine whether U.S. and Chinese teachers' pedagogical beliefs (T-PB) differed from their perceptions of their culture's pedagogical beliefs (TP-CPB). Using independent assessments can provide insight as to why teachers' beliefs may not always align with their practices and also point to broader sociocultural

barriers that may reinforce instructional practices that are inconsistent with teachers' personal beliefs. How Chinese and U.S. educators negotiate these points of tension in their teaching practice deserves more research. Future studies can use similar methods to corroborate these findings with larger and more representative samples.

Limitations

This study had some limitations that should be acknowledged when interpreting its findings. The present study uses mixed methods to provide an in-depth understanding of a small number of U.S. and Chinese middle school mathematics teachers' perspectives on their own beliefs as well as their culture's. The findings on teachers' perceptions of cultural pedagogical beliefs (TP-CPB) describe a small number of teachers' *perceptions* of the broader cultural beliefs, values, and norms. These findings should not be interpreted as generalizations about American or Chinese cultural beliefs about teaching and learning. Another consideration is that the Chinese participants from this study were recruited from the same institution in a large city in Jiangsu province, while the U.S. participants were recruited from different institutions across four states. Nevertheless, the findings from this study raise new questions for teacher educators and researchers interested in cross-cultural comparisons of teachers' pedagogical beliefs and practices.

Conclusion

This study examined the extent to which stereotypes about "Western" and "Eastern" pedagogy match up with contemporary American and Chinese teachers' beliefs about teaching and learning mathematics. These findings suggest that U.S. and Chinese teachers' *personal* pedagogical beliefs (T-PB) are more aligned with stereotypically "Western" pedagogical features; however, U.S. and Chinese teachers' perceptions of their *culture's* pedagogical beliefs

(TP-CPB) are more “Eastern”-oriented. Interview data reveal that these differences stem from culturally-rooted expectations which create tensions between teachers’ personal teaching orientation (i.e., more student-centered) and their actual teaching practice (i.e., more teacher-directed) for American and Chinese teachers. These findings offer insights into the pedagogical shifts that teachers in both countries experience; they also identify specific culturally-rooted pedagogical features that continue to influence American and Chinese teachers’ beliefs about mathematics education.

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PAPER TWO. Culturally Shaped Noticing: The Role of Personal and Cultural Beliefs on Teacher Noticing

Abstract

An emerging line of research points to key differences between Western and East Asian teachers' noticing patterns (Damrau et al., 2022; Ding et al., 2022; Yang et al., 2019). Researchers attribute these differences to underlying cultural beliefs about teaching and learning (Ding et al., 2022; Yang et al., 2019). However, the role of culture on what teachers notice remains unclear due to the methods used in these studies. Prior research has tended to infer teachers' cultural beliefs from what they notice. This approach conflates teachers' beliefs with noticing and makes the influence of culture on noticing difficult to determine. Thus, there is a need to independently assess, rather than infer, teachers' beliefs about teaching and learning mathematics. It is also necessary to distinguish teachers' personal views from their perceptions of their culture's views on mathematics education since it's hypothesized that teachers' cultural beliefs exert more influence on how they perceive and respond to instructional events than personal beliefs (An et al., 2006; Tobin et al., 2009; Yang et al., 2020). This study uses independent measures of teacher noticing and underlying beliefs to examine how they might connect to cultural features (Leung, 2001). Twelve middle school math teachers (6 U.S. and 6 Chinese) completed surveys and interviews about their beliefs and what they noticed in response to two mathematics lessons. Cross-cultural differences were observed in U.S. and Chinese teachers' noticing patterns. Further, these differences appear to be related to stereotypically "Western" and "Eastern" pedagogical features (SPFs). U.S. teachers' noticing patterns and pedagogical beliefs (T-PB) were more aligned with "Western" features; Chinese teachers'

noticing patterns and perceptions of their culture's pedagogical beliefs (TP-CPB) were more consistent with "Eastern" features.

Introduction

Improving instructional practice begins with changing how teachers attend, interpret, and respond to classroom events (Choy, 2013; Lee et al., 2018). Collectively, these processes are referred to as *teacher noticing* (van Es & Sherin, 2008). What teachers notice, or fail to notice, in the classroom informs their instructional decisions (Gibson & Ross, 2016; Mason, 2002; Star & Strickland, 2008). Teacher noticing is shaped at least in part by cultural values, norms, and beliefs (Yang et al., 2019; Ball, 2011). It is therefore important to understand the cultural factors that shape teachers' noticing so we can better support teachers in developing the perceptual skills necessary for making meaningful shifts in instructional practice.

Prior studies make clear that teachers from Western and East Asian cultural contexts attend, interpret, and respond to classroom events differently. Study after study has shown that East Asian teachers' noticing tend to be more focused on mathematical content and students' mathematical thinking, whereas Western teachers tend to notice general pedagogical aspects such as classroom management and social interactions (Bork & Zhu, 2022; Damrau et al., 2022; Ding et al., 2022; Dreher et al., 2021; Miller & Zhou, 2007; Yang et al., 2019; 2021). These findings indicate cultural differences between Western and East Asian teachers' noticing patterns.

Scholars theorize that these cultural differences stem from the values, norms, and practices typically associated with "Western" and "Eastern" educational traditions (Yang et al., 2019; Dreher et al., 2021). Historically rooted values, norms, and practices form cultural stereotypes about "Western" and "Eastern" pedagogy (Yang et al., 2019; Dreher et al., 2021).

These cultural stereotypes—stereotypical pedagogical features-- become internalized as part of these teachers' belief systems which, in turn, inform what they notice. Tobin (2009) argues that these culturally-rooted pedagogical features, passed from one generation to the next, may influence what teachers perceive and how they respond to classroom events in ways that may be more powerful and enduring than teachers' personal beliefs.

Yet, there is little empirical evidence to support these claims. Few studies have directly examined the influence of culture *or* teachers' beliefs on what they notice. Across many studies, the influence of culture is not assessed independently from what teachers notice, making it difficult to describe the relationship between the two (Huang & Li, 2012; Ding & Dominguez, 2016). This study will take a closer look at the influence of these culturally-shaped expectations about teaching and learning—stereotypical pedagogical features (SPFs)— on what teachers believe and notice. Understanding how these cultural stereotypes inform teachers' beliefs and noticing patterns can help us provide more targeted support for improving Western and East Asian teachers' noticing skills.

Review of the Literature

Teacher Noticing in Mathematics Education

Good teaching begins with the teacher's ability to attend, interpret, and respond to what is going on in the classroom (van Es & Sherin, 2002; Gibson & Ross, 2016). This set of skills is referred to as "teacher noticing" or "professional noticing". Teacher noticing is broadly defined as a process in which teachers draw upon their knowledge and beliefs in order to attend, interpret, and respond to key instructional events (van Es & Sherin, 2002; 2008; Goodwin, 2015).

What teachers notice, or fail to notice, in the classroom informs their instructional decisions (Gibson & Ross, 2016; Mason 2002; Star & Strickland, 2008). Teacher noticing is linked to high-impact practices such as eliciting students' mathematical thinking (Kaiser et al., 2015), attending to students' mathematical strengths (Jilk, 2016), supporting students' conceptual understanding (Schifter, 2011), and creating richer instructional activities (Kersting et al., 2012; Hoth et al., 2017; Star & Strickland, 2008). These high-impact practices lead to higher student learning outcomes (Jacobs et al., 2010; Kersting et al. 2010). Thus, the connections between teacher noticing and good teaching makes this an important area of focus for researchers and educators alike.

Teacher Beliefs in Mathematics Education

What teachers pay attention to and how they interpret and respond to instructional practice are influenced by their pedagogical beliefs (Stahnke et al., 2016). *Pedagogical beliefs* are broadly defined as "psychologically held understandings, premises, or propositions" about teaching and learning (Philipp, 2007, p. 259). In mathematics education, teachers' pedagogical beliefs refer to teachers' views about the nature of mathematics, and beliefs about how mathematics should be taught and learned (Ernest, 1989; Thompson, 1992). Pedagogical beliefs can vary from individual to individual, as well as from culture to culture.

The term "cultural beliefs" stems from Bruner's (1996) "folk pedagogy" construct, which is defined as "taken-for-granted practices that emerge from embedded cultural beliefs about how children learn and how teachers should teach" (p. 46). Scholars theorize that cultural pedagogical beliefs may subliminally guide teachers' attention and responses to classroom events in ways that may be at odds with their personal beliefs (Tobin et al., 2009; Louie, 2018). For example, a

teacher may believe that students should be allowed to freely explore and make mistakes yet may unconsciously intervene to prevent student error.

Comparing Western and East Asian Teachers' Noticing in Mathematics

An emerging line of cross-cultural studies points to key differences between Western and Eastern Asian teacher noticing patterns. In the following sections, I apply the Attending-Interpreting-Responding (AIR) framework as an organizational framework to review the literature on teacher noticing. The AIR framework is also applied as an analytic lens for the findings (see Conceptual Framework) (van Es & Sherin, 2008; Louie et al., 2021). The AIR framework is widely used and decomposes noticing in ways that facilitate assessment and analysis (van Es & Sherin, 2008; Jacobs et al., 2010; Jessup, 2018; Huang & Li, 2012). Below, I provide an overview of comparative research examining how which Western and Eastern mathematics teachers attend, interpret, and respond to instructional events or content. These findings are summarized and discussed below.

Attending

Many studies have reported that Western teachers pay more attention to the classroom environment whereas East Asian teachers pay more attention to mathematics content and students' mathematical thinking (Bork & Zhu, 2022; Ding et al., 2022; Damrau et al., 2022; Huang & Li, 2012; Miller & Zhou, 2007). Bork & Zhu's (2022) comparison of U.S. and HK teachers' noticing of TIMSS geometry lessons found that HK participants focused more on the subject matter (*Mathematics*); U.S. participants focused more on the social environment (*Climate*) and classroom organization (*Management*). Similarly, Damrau et al.'s (2022) case study found that the Chinese teacher paid more attention to student knowledge and the lesson content and less attention to time management, preparation, and use of resources compared to the

Australian and German teachers. Similar results have been reported in earlier studies of teacher noticing (Huang & Li, 2012; Miller & Zhou, 2007).

Interpreting/evaluating

Western teachers tend to evaluate the teacher's general pedagogical practices whereas East Asian teachers tend to evaluate lessons based on mathematical content and student learning. For example, in Miller and Zhou's (2007) study, the U.S. teachers made significantly more evaluative comments about the teacher's general pedagogical practices such as classroom management, participation, classroom structure, and motivational strategies. In contrast, Chinese teachers made more evaluations of the lesson's mathematical content and its impact on students' mathematical understanding. Similarly, Yang et al. 's (2019) study reported that German teachers outperformed Chinese teachers in analyzing aspects related to general pedagogy, whereas Chinese teachers outperformed German teachers in analyzing aspects related to mathematics content and students' mathematical thinking. Western and East Asian teachers may also interpret and evaluate student thinking differently. Dreher et al.'s study (2021) found that Taiwanese experts tend to evaluate students' thinking based on the correctness of students' answers, whereas German teachers evaluate the students' processes of doing mathematics.

Another difference is that East Asian teachers appear to hold higher standards for evaluating student learning and instructional content (Damrau et al., 2022; Ding et al., 2022; Dreher et al., 2020). The East Asian teachers (Chinese and Taiwanese) in these studies were less satisfied with student-centered instructional methods than the Western teachers (U.S., Australian, and German). For example, when evaluating a set of deep-thinking questions, U.S. teachers felt that they effectively elicited students' computational thinking strategies, while Chinese teachers noticed missed opportunities to further elicit students' mathematical ideas (Ding et al., 2022).

Overall, Western teachers appear to be more easily satisfied by lessons that elicit students' engagement whereas East Asian teachers expect to see more learning gains. Damrau et al. (2022) attribute this finding to the Chinese cultural view that "strict teachers produce outstanding students." It appears that Western teachers may be more likely to interpret and evaluate student-centered instruction more positively than East Asian educators, who may be inclined towards more teacher-directed instructional methods.

Responding

Yang et al.'s (2019) study conducted a video-based noticing assessment task with 203 Chinese and 118 German teachers. Yang et al.'s (2019) study indicate that German teachers were better at identifying and adapting the lesson to fit students' learning preferences. German teachers were better at proposing multiple ways to represent mathematical concepts (e.g., formal equations, diagrams, and manipulatives). These findings are corroborated by Ding et al.'s (2022) study, which reported that U.S. teachers focused more on concrete representations, while Chinese teachers attended to representational sequences (e.g., from concrete and abstract) (Ding et al., 2019; 2022). In contrast, Chinese teachers were more skillful at explaining and summarizing the main ideas in teaching activities.

Western and East Asian Beliefs about Mathematics Education

The construct of "culture" is too broad to be measured directly and therefore must be inferred through indirect assessments of teachers' beliefs and values (Lenartowicz & Roth, 1999). Thus, I reviewed the literature on cross-cultural comparisons of teacher's beliefs to develop a typology of "Western" and "East Asian" educational features. These studies examined teachers' beliefs across three main areas: (1) beliefs about the nature of mathematics (Bryan et al., 2008; Cai & Wang, 2006; Cai & Wang, 2006; Yang et al., 2020;), (2) beliefs about how mathematics should

be taught (Cai & Wang, 2010; Li et al., 2018; 2019), and (3) beliefs about how students best learn mathematics (Correa et al., 2008; An et al., 2006). The findings from these studies demonstrate that Western and East Asian teachers hold distinct and internally consistent views about what constitutes effective mathematics teaching and learning. (Correa et al., 2008; Tobin et al., 2009; Yang et al, 2020; Li et al., 2018).

Beliefs about the Nature of Mathematics

U.S. and Chinese teachers hold different views about the nature of mathematics which leads to different approaches to evaluating mathematics learning. Chinese teachers conceptualize mathematics as a rigid body of knowledge with precise rules and procedures (Bryan et al., 2007). Chinese teachers tend to deeply appreciate the internal logic of mathematics (Cai & Wang, 2010; Leung, 1995). In contrast, the Western view of mathematics tends to be more dynamic—mathematics is conceptualized as an inquiry process. In this view, the emphasis is learning the process of inquiry rather than the mathematical content itself (Leung, 2001). For example, Chinese teachers tend to emphasize the correctness of the students' solution, strategy use, and mathematical explanations, while U.S. teachers tend to emphasize students' process of inquiry, often encouraging novel solutions and strategies (Cai & Wang, 2010; Cai & Wang, 2006; Bryan et al., 2007).

Beliefs about how Mathematics Should be Taught

U.S. and Chinese teachers' views about how to teach mathematics differ across six dimensions: teaching methods, class structure, lesson structure, rote learning, teacher expertise, and teacher praise. Chinese teachers tend to have more of a teacher-led view of classroom instruction than U.S. teachers, who tend to hold more student-centered views (Cai & Wang, 2010; An et al., 2006) and display a strong resistance towards instructivism (Li et al., 2019;

Bredekamp, 2004). Chinese and U.S. teachers' beliefs about teaching methods may be related to their views on classroom structure. Chinese teachers regularly teach class sizes of 40-60 students, making individualized instruction very difficult. Chinese teachers believe that providing clear, explicit instruction to the whole class is important for effective learning (Bryan et al., 2007; Cai and Wang 2010), whereas American teachers prefer small-group instruction or independent teaching over whole group instruction (Correa et al., 2008; Li et al., 2019; Zhu, n.d.).

Several studies have found that Chinese and U.S. hold different views about what makes a good lesson. For Chinese teachers, a good lesson has a coherent structure with a strong connection of mathematical ideas throughout all activities (Cai & Wang, 2010; Correa et al., 2008; An et al., 2004; Li et al., 2018). On the other hand, U.S. teachers prefer shorter lessons with less seatwork (Li et al., 2019; Correa et al., 2008). They favor loosely-structured lessons and encourage spontaneous discussions that arise from student input (Li et al., 2019; Cai & Wang, 2010).

Western and East Asian teachers agree that "rote learning", or repeated practice and memorization, is an essential part of learning (Correa et al., 2008; Cai & Wang, 2010). However, U.S. and Chinese teachers also hold differing beliefs about the role of rote memorization in the learning process. Chinese teachers believe that rote learning could serve as a way to develop conceptual understanding (Cai & Wang, 2010). U.S. teachers disagree, arguing that the emphasis on memorization can only come after students have developed conceptual understanding.

Concerning teacher expertise, Chinese teachers believe that subject matter knowledge is essential for effective mathematics instruction (Cai & Wang, 2010; Li et al., 2018; An et al., 2006; Correa et al., 2008). On the other hand, U.S. educators believe that general pedagogical

knowledge, such as classroom management, to be the most important quality of a good teacher (Cai & Wang, 2010; An et al., 2006; Li et al., 2018).

Chinese and U.S. teachers also appear to hold differing beliefs on how teachers should praise students. Chinese teachers believe that a good teacher should not be overly generous with praise to maintain high standards. This view is consistent with a famous Chinese idiom: “A strict teacher produces outstanding students” (Li et al., 2018). On the other hand, American teachers are more inclined to use praise more generously (Cai & Wang, 2010, Li et al., 2018).

Beliefs about how Students Best Learn Mathematics

In comparing teachers’ beliefs about how students best learn mathematics (Correa et al., 2008; An et al., 2006), U.S. and Chinese teachers hold different views on the following three dimensions: learning process, conceptual understanding, and motivation.

Chinese teacher tend to believe that deep learning occurs when students are engaged in rigorous study whereas U.S. teachers tend to believe that learning should be more fun and engaging. Chinese teachers believe that effective teaching means maintaining a level of mathematical rigor and discipline (Li et al., 2018). The cultural roots of this belief is reflected in the Chinese adage: "the root of knowledge is bitter; its fruits are sweet” (Leung, 2001). In contrast, American teachers prefer more hands-on activities, peer interactions, and emphasize the importance of using humor to create a more enjoyable learning environment (Cai & Wang, 2010; Li et al., 2019). American teachers highly value “active learning” methods such as using concrete manipulatives and small group work (An et al., 2006; Correa et al., 2008).

Previous cross-cultural studies of teachers’ beliefs suggest that Western educators believe that students should be intrinsically-motivated whereas East Asian educators believe in the extrinsic motivators such as parental expectations, social support, and examinations (Watkins &

Biggs, 1996; 2000). However, more recent studies show that both Chinese and U.S. teachers seem to believe in the importance of sparking intrinsic motivation (Correa et al., 2008; Lu & Kaiser, 2022; Niu et al., 2017).

These findings suggest that U.S. and Chinese teachers' beliefs about mathematics education are clearly influenced by their cultural contexts. Leung (2001) argues that these features are rooted in underlying cultural beliefs, which are presented in contrast to the cultural values and beliefs in Western mathematics education (Leung 2001)**.** From this literature review, I generated a list of 10 dimensions to serve as a framework for analyzing differences in teachers' beliefs (*Western and East Asian Features of Mathematics Education*) which organizes commonly reported differences in teachers' beliefs along common themes

Summary and Critique

The influence of culture on what teachers notice and believe has largely been inferred from group differences between Western and East Asian teachers. Typically, teachers from Western and East Asian cultural contexts are asked to observe videos of teaching from each country. The influence of culture on noticing has been inferred in two ways: when teachers notice different things or hold different pedagogical beliefs, researchers infer it is due to culture. However, these claims may present an issue of reverse causation: differences in what teachers notice or believe may point to the *effects* of cultural influence— but what are the specific culturally-specific features that *cause* these differences?

My review of these two bodies of research points to potential areas of overlap between what teachers notice and what they believe. For example, studies on teacher noticing reported that East Asian teachers tend to focus more on formal abstract representations while Western teachers attend more to concrete manipulative or visual diagrams (Ding et al., 2019; 2022; Yang

et al., 2019). These findings are similar to studies of teacher beliefs indicating that East Asian teachers believe that mathematics should best be taught using formal abstract representations whereas Western teachers prefer using alternative representations such as concrete manipulatives (Cai & Wang, 2010). These studies demonstrate that significant differences do exist in teachers' noticing; moreover, these differences are thought to be rooted in "Western" and "Eastern" cultures of teaching and learning (Leung, 2001). However, we need more empirical studies to establish these relationships. This study applies video-cued methods to examine the potential influence of "Western" or "Eastern" culture on teachers' beliefs and noticing.

More Cross-Cultural Comparisons of Teacher Noticing Patterns in Response to the Same Classroom Events are Needed to Confirm Group Differences

Teacher noticing can be difficult to assess and compare across cultures. Typically, teacher noticing is assessed in one of the following ways: most studies examine what teachers notice in response to video clips or text-based vignettes from a single cultural context (Huang & Li, 2012; Yang et al., 2019; Miller & Zhou, 2007; Dreher et al., 2020); others compare and contrast what teachers from different countries notice upon observing their own classroom practices or materials (Dramrau et al., 2022; Ding et al., 2019). The issue with these assessments is that they do not provide a basis for cross-cultural comparison. For example, we need to compare what teachers from Western and Eastern cultural contexts notice when presented with similar scenarios.

In the few studies that have compared what Western and Eastern teachers notice upon observing lessons from two cultural contexts, it appears that teachers seem to notice different things about each lesson (Ding et al., 2022; Bork & Zhu, *n.d.*). For example, Ding et al. (2022) reported that Chinese teachers paid more attention to concrete representations when observing

U.S. lessons while American teachers paid most of their attention to the teacher's guidance and questioning in the Chinese lesson. This suggests that some of the group differences observed in Western and East Asian teachers' noticing may simply be due to underlying differences instructional style and cultural contexts that are commonplace in those countries.

In this study, video-cued methodology will be used to elicit and compare teacher noticing in response to two lessons from two cultural contexts (e.g., U.S. and Hong Kong). These video cases represent stereotypically "Western" and "Eastern" teaching styles: student-centered and teacher-directed. Comparing what teachers Western and East Asian teachers notice upon observing lessons from two cultural contexts can reveal which aspects of teacher noticing might be due to the instructional methods (e.g., student-centered versus teacher-directed) shown in the videos. For instance, participants observing a student-centered lesson may focus more on students; likewise, participants observing a teacher-directed lesson will naturally pay more attention to the teacher and instructional materials. However, if these differences persist across instructional styles, there may be a stronger argument for culturally-shaped patterns of noticing.

The Relationship between Culture on Teachers' Beliefs and Noticing Remains Unclear

Prior research has tended to infer teachers' cultural beliefs from the things they notice. This approach conflates beliefs and noticing and makes the influence of culture on noticing difficult to determine. To the best of my knowledge, no cross-cultural studies have examined teachers' pedagogical beliefs in relation to what they notice. Thus, there is a need to more independently assess, rather than infer, culturally-rooted beliefs about teaching and learning. Examining teachers' belief systems can reveal both personally-held and culturally-rooted values, expectations, and norms about teaching and learning.

Another issue is that most studies of teachers' pedagogical beliefs do not distinguish between teachers' personal views and the broader cultural assumptions about teaching and learning. Prior studies suggest that cultural beliefs about teaching and learning can greatly influence what they do in the classroom, even more so than personal beliefs (An et al., 2006; Tobin et al., 2009; Yang et al., 2020). Most cross-cultural comparisons of teachers' beliefs ask teachers to describe or rate their personal beliefs about teaching and learning. Differences in teachers' personal beliefs are then attributed to culture. From this analysis, it would be more prudent to conclude that different teachers believe different things.

Study Purpose

This study will use video-cued interview and survey methods to compare U.S. and Chinese teacher noticing (TN) patterns in relation to their pedagogical beliefs (T-PB) and perceptions of their culture's pedagogical beliefs (TP-CPB). This serves a two-fold purpose: (1) to examine what U.S. and Chinese teachers notice about student-centered instruction versus teacher-directed instruction; and (2) to explore the relationship between teachers' pedagogical beliefs (T-PB) and perceived cultural pedagogical beliefs (TP-CPB) on shaping what teachers notice (TN).

Research Questions

Two overarching assumptions inform this study. The first presupposition is that teacher noticing is shaped at least in part by "Western" and "Eastern" educational traditions (Ball, 2011; Yang et al., 2019). Therefore, I anticipate that U.S. and Chinese teachers will attend, interpret, and respond to the video clips differently. Specifically, I anticipate that U.S. teachers will attend to more aspects related to the classroom environment and social interactions (i.e., students and classroom atmosphere); in contrast, Chinese teachers will pay more attention to the instructional

aspects (i.e., teacher explanations, teaching material) (H1). Previous findings indicate that Western teachers' conceptions of excellent teaching tend to be more student-centered whereas East Asian teachers' conceptions tend to be more teacher-directed (Chen & Brown, 2013; Chen, 2015). Therefore, it is expected that these U.S. teachers should evaluate the student-centered lesson more positively than the Chinese teachers; Chinese teachers should evaluate the teacher-directed lesson more positively than the U.S. teachers. (H2). Finally, I anticipate that teachers' instructional responses will be consistent with their respective cultural traditions. That is, U.S. teachers' responses will be more in line with "Western" SPFs whereas Chinese teachers' responses will be more in line with "Eastern" SPFs (H3).

Secondly, I argue that teachers' perceptions of their culture's pedagogical beliefs (TP-CPB) may influence what they notice more so than their own pedagogical beliefs (T-PB). Therefore, teachers' noticing patterns will be more aligned with their perceptions of their culture's pedagogical beliefs (TP-CPB) (H4). To investigate these hypotheses, the study investigates the following questions:

RQ1: What do U.S. and Chinese middle school teachers notice upon observing a student-centered lesson and a teacher-directed lesson?

RQ1a. What do U.S. and Chinese teachers attend to in these lessons?

Hypothesis 1. U.S. teachers will pay more attention to classroom management and students whereas Chinese teachers will pay more attention to teachers' explanations and teaching materials.

RQ1b. How do U.S. and Chinese teachers interpret/evaluate these lessons?

Hypothesis 2. U.S. teachers will interpret the student-centered lesson more positively than the Chinese teachers; Chinese teachers will interpret the teacher-directed lesson more positively than the U.S. teachers.

RQ1c. How do U.S. and Chinese teachers respond to these lessons?

Hypothesis 3. U.S. teachers' responses will reflect more "Western" features; Chinese teachers' response will reflect more "Eastern" features.

RQ2: To what extent are U.S. and Chinese teachers' noticing in agreement with their pedagogical beliefs (T-PB)? To what extent are U.S. and Chinese teachers' noticing in agreement with their perceptions of cultural pedagogical beliefs (TP-CPB) about mathematics education?

Hypothesis 4. Teachers' noticing will be more in agreement with their perceptions of cultural pedagogical beliefs (TP-CPB) than their pedagogical beliefs (T-PB).

Conceptual Framework

This study was framed by three areas of literature: cross-cultural comparative research, teachers' beliefs, and teacher noticing. I begin by presenting the *Western and East Asian Features of Mathematics Education* (adapted from Leung, 2001) framework as a foundation for identifying "Western" and "Eastern" stereotypical pedagogical features (SPFs). I apply Ernest's (1989) framework for identifying pedagogical beliefs and van Es and Sherin's (2008) *Attending, Interpreting, Responding* framework to define teacher noticing.

Western and East Asian Features of Mathematics Education

The *Western and East Asian Features of Mathematics Education* (adapted from Leung, 2001) will be applied to identify the stereotypical pedagogical features (SPFs) typically associated with "Western" and "Eastern" approaches to mathematics education. This framework

captures key differences between the East Asian and the Western traditions in mathematics education along 10 dichotomies: (1) *process versus product*; (2) *child-centered versus teacher-directed;* (3) *pleasurable learning versus studying hard*; (4) *individualized learning versus whole class teaching*; (5) *pedagogical knowledge versus subject matter knowledge*; (6) *meaningful learning versus rote learning*; (7) *intrinsic versus extrinsic motivation*; (8) *generous praise versus limited praise*, (9) *less-structured versus highly-structured*, and (10) *concrete versus abstract*.

Pedagogical Beliefs

In the context of mathematics education, teachers' pedagogical beliefs refer to teachers' views about the nature of mathematics, and beliefs about how mathematics should be taught and learned (Ernest, 1989; Thompson, 1992). This study differentiates the pedagogical beliefs held by the individual (teacher's pedagogical beliefs) from the collective (teacher's perceptions of cultural pedagogical beliefs). I define *teachers' pedagogical beliefs* (T-PB) in terms of their personal views about: (1) the nature of mathematics; (2) how mathematics should be taught, and (3) how students best learn mathematics (Correa et al., learning (Ernest 1989; Speer 2005; Thompson 1992*). Teacher's Perception of Cultural Pedagogical Beliefs (TP-CPB)* refers to the participant's perceptions of widely held cultural beliefs about: (1) the nature of mathematics; (2) how mathematics should be taught, and (3) how students best learn mathematics.

Attending, Interpreting, and Responding (AIR) Framework

Teacher noticing can be operationalized and assessed in various ways depending on the research context and aims. In mathematics education, much of the work on teacher noticing has been conducted in the context of professional development, during which teachers interact with classroom videos **(**Sherin & van Es, 2005; 2009) or student artifacts (Jacobs et al., 2011). Others

have studied teachers' in-the-moment noticing during classroom instruction (Sherin & Van Es, 2009; 2010). This study applies van Es and Sherin's (2002; 2008) seminal framework which conceptualizes teacher noticing as a set of 3 interrelated skills:

- attending to critical events;
- interpreting or evaluating observed events
- responding to observed events based on what was attended to and the interpretations that were made

Method

This study employs video-cued methodology to elicit teachers' beliefs and noticing patterns (Tobin et al., 2009). This study uses three methods of data collection: interviews, survey, and a task-based assessment. These methods were used to gather data for the following constructs: teachers' pedagogical beliefs (T-PB), teachers' perceptions of cultural pedagogical beliefs (TP-CPB), and teacher noticing. Quantitative measures provide the basis for cross-cultural comparisons of the extent to which participants' beliefs and noticing patterns were consistent with stereotypical pedagogical features (SPFs). Qualitative methods, such as open-ended prompts and interview questions, were used to identify SPFs through thematic analysis.

Participants

12 middle school mathematics participants from U.S. and mainland China were recruited to participate in this study. U.S. teacher participants included six middle school mathematics teachers (all female) from various schools across three different states. All six teachers worked in public schools. Five of these teachers worked in middle-sized Midwestern U.S. cities while one teacher worked in a rural setting. Chinese teacher participants included six middle school teachers (4 females, 2 males) from two different public schools in Nanjing.

Measures

Teacher Noticing Task

Participants observed four video clips of mathematics lessons from a student-centered lesson and a teacher-directed lesson. The student-centered lesson ("Graphing Linear Equations") features an U.S. eighth-grade classroom while the teacher-directed lesson ("Simultaneous Linear Equations) features an eight-grade classroom in Hong Kong (HK). The "Graphing Linear Equations" lesson was designated as a "student-centered lesson" and the "Simultaneous Linear Equations" lesson was designated as a "teacher-directed lesson" by the participants. When discussing the contrasts between the two lessons, participants frequently employed "student-centered" or "teacher-directed" to describe the teaching methods in these classrooms.

These video clips are taken from the *Trends in International Mathematics and Science Study* (TIMSS) dataset. Participants observed a 10-minute clip of general instruction for each lesson followed by a 2-minute clip of teacher-student interactions. The participants completed an 18-item questionnaire consisting of six closed-ended and 12 open-ended items. Question items were designed to elicit the *attending*, *interpreting*, and *responding* processes that comprise teacher noticing (van Es and Sherin, 2008).

Structured Interview

A 60-minute structured interview was conducted with each participant to capture teachers' attentional, interpretations, and responding processes more fully upon observing each lesson video. The interview protocol included 3 open-ended questions followed by 7 tailored questions. The tailored interview questions were designed to prompt participants to clarify and elaborate on their responses to the *Teacher Noticing Task*.

Teacher Beliefs Survey

Participants completed a 40-item questionnaire consisting of closed and open-ended items about their personal and cultural views about teaching and learning. The pedagogical beliefs measure will consist of 40 items generated from the *Features of Western and East Asian Mathematics* framework (adapted from Leung, 2001). Participants indicated the degree to which each statement agreed or disagreed with their personal views (T-PB) and their culture's views (TP-CPB) using a 4-point Likert scale (1 = "strongly disagree", 4 = "strongly agree").

Data Analysis

The data analysis process followed three phrases: (1) quantitative analyses of survey data (2) qualitative analyses of interview data; (3) integrative analyses of quantitative and qualitative data.

Phase 1. Quantitative Analyses

Quantitative results from the participant responses to the *Teacher Noticing Task* was used to explore group-level differences. A one-tailed Mann-Whitney U-test was conducted to test for significant differences in U.S. and Chinese teachers' *attending* and *evaluating* scores. Quantitative analysis of the *Teacher Beliefs Survey* consisted of generating descriptive statistics (medians, standard deviations, differences) to analyze the extent to which teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CBP) agree with stereotypical pedagogical features (SPFs). Participants' responses were aggregated at the group-level to explore the extent to which U.S. and Chinese teachers' pedagogical beliefs (T-PB) and perceptions of cultural pedagogical beliefs (TP-CPB) agree with "Western" or "East Asian" features.

Phase 2. Qualitative Analyses

Qualitative analyses were collected from questionnaires and interviews. Each teacher participated in an interview following the completion of the *Teacher Noticing Task* and *Teacher Beliefs Survey.* Teacher responses to the open-ended prompts in the *Teacher Noticing Task* were coded in two steps. The first coding step sorted teachers' statements into Attending, Interpreting/Evaluating, and Responding components according to the *Learning to Notice* framework (van Es and Sherin, 2008) as an a priori noticing frame. The second step applied the *Western and East Asian Features of Mathematics Education* framework (adapted from Leung, 2001) to identify instances of stereotypical pedagogical features (SPFs) across teachers' noticing patterns.

Transcripts of the 12 teacher interviews followed a similar two-step process. I first read the transcripts in their entirety and then highlighted passages in which teachers discussed: (a) personal expectations, beliefs, norms, or preferences about teaching and learning mathematics or (b) cultural expectations, beliefs, norms, or preferences about teaching and learning. Statements expressing teachers' personal pedagogical beliefs or perceptions of the cultural pedagogical beliefs were identified by the PI and assembled in a separate document for each teacher. Excerpts were then coded using the *Western and East Asian Features of Mathematics Education* framework. Once the final coding frame had been established, it was applied to all passages by two external raters. IRR was high at 86% after two rounds of coding.

Phase 3. Convergent analyses

To explore the connections between teachers' beliefs and noticing, teacher noticing transcripts were scored on a four-point rubric. Content analyses were conducted to evaluate teacher noticing patterns in relation to the predetermined stereotypical pedagogical features. For

each feature, teachers' noticing responses were assigned scores from 0 to 3, with 0 indicating no evidence of noticing, 1 indicating attending to the feature, 2 indicating evidence of attending and interpreting, and 3 indicating that the teacher attended, interpreted, and responded in ways that were consistent with the feature. Two external raters coded the entries independently, resulting in an inter-rater agreement of 93% after three rounds of coding and discussion. Teacher noticing scores were aggregated at the group level and analyzed in relation to teachers' belief ratings.

Findings

RQ1. What do U.S. and Chinese middle school teachers notice upon observing a student-centered lesson and a teacher-directed lesson?

Overall, these results support H1 and H3 but contradict H2. Consistent with H1, U.S. teachers paid significantly more attention to classroom management for both lessons, whereas Chinese teachers paid significantly more attention to the teachers' explanations for both lessons (Tables 1 and 2). However, both U.S. and Chinese teachers rated the student-centered and teacher-directed lessons similarly, contradicting the hypothesis that U.S. teachers will evaluate the student-centered lesson more positively, whereas Chinese teachers will evaluate the teacher-directed lesson more positively (H2). Finally, the U.S. teachers made more instructional responses concerning classroom management and atmosphere, whereas Chinese teachers responded more to the teacher guidance and improving students' mathematical thinking, providing support for H3.

In line with H1, quantitative findings showed that these U.S. teachers paid significantly more attention to classroom management for both lessons whereas Chinese teachers paid significantly more attention to the teachers' explanations for both lessons (Table 1). When asked to describe what stood out to them about the student-centered lesson, both U.S. and Chinese

teachers attended to "Western" features such as *general pedagogical knowledge*, *child-centeredness,* and *individualized learning* (Table 2). Upon watching the teacher-directed lesson, both groups of teachers pointed out the "Eastern" features (e.g., *teacher-directedness, limited use of praise, highly-structured lesson, subject matter knowledge*).

Quantitative findings: comparing U.S. and Chinese teachers' level of attention to different aspects of the student-centered lesson (U.S. classroom)

Based on the Mann–Whitney test, there were significant differences between U.S. and Chinese teachers' level of attention across two aspects of the student-centered lesson (Table 2.1). U.S. teachers paid significantly greater attention to the classroom management (Median [$M_{U.S.}$] = 4.5) than the Chinese teachers (M_{CH} = 2.5), $U = 0$, $p < .01$. Chinese teachers paid significantly more attention to the teachers' explanations (M_{CH} = 4.8) than the U.S. teachers ($M_{U.S.}$ = 3.2), U = 1.5, $p < .05$.

Moderate differences were found between U.S. and Chinese teachers' level of attention to the students, classroom environment, and teaching material. U.S. teachers paid more attention to the students ($M_{U.S.}$ = 4.2) and classroom environment ($M_{U.S.}$ = 2.5) than the Chinese teachers (M_{CH} = 2.8 and M_{CH} = 1.7 correspondently). However, the Chinese teachers paid more attention to the teaching material (M_{CH} = 4.5) compared to the U.S. teachers ($M_{U.S.}$ = 3.8).

Table 2.1 Differences between U.S. and Chinese teachers' level of attention to components of student-centeredlesson (U.S. classroom)

Components	U.S. Median	Chinese Median	*U*	*r*
Students	4	2.5	8	0.63
Teacher Explanations	3.5	5.0	1.5*	0.78
Classroom Management	4.5	2.5	0**	0.88
Teaching Material	4.0	4.5	13.5	0.2
Classroom Environment	2.5	2.0	9	0.47

Note. *r* = effect size
*** p <.05** **** p <.01**

Qualitative findings: U.S. and Chinese teachers' descriptions of noteworthy aspects in the student-centered lesson (U.S. classroom)

When asked to describe what stood out to them in the student-centered lesson, the U.S. teachers paid the most attention to the teacher's *general pedagogical knowledge* (100%) and the teacher's *generous use of praise* (100%). Chinese teachers paid the most attention to the *child-centered* aspects of the lesson (100%) and the activities that supported *individualized learning* (100%). The Chinese teachers (100%) also noticed aspects concerning students' grasp of the learning content (*product-oriented*) as indicated by their verbal responses and written work whereas none of the U.S. teachers explicitly attended to the students' grasp of learning outcomes for the student-centered lesson.

Quantitative findings: comparing U.S. and Chinese teachers' level of attention to different aspects of the teacher-directed lesson (HK classroom)

U.S. and Chinese teachers significantly differed in terms of the level of attention paid to classroom management and teaching material (Table 2). Similar to the student-centered lesson, U.S. teachers paid significantly greater attention to the classroom management (Median [$M_{U.S.}$ =

4.3) than the Chinese teachers (M_{CH} = 2.5), U = 0, p < .01. Chinese teachers paid significantly more attention to the teaching material (M_{CH} = 4.5) than the U.S. teachers ($M_{U.S.}$ = 2.3), U = 1.5, p < .05.

In contrast to the student-centered lesson, U.S. and Chinese teachers did *not* significantly differ in their level of attention to the teacher's explanation in the teacher-directed lesson (Table 2). This is because the U.S. teachers paid more attention to teacher's explanations ($M_{U.S.}$ = 4.2) in the teacher-directed lesson in comparison to the student-centered lesson ($M_{U.S.}$ = 3.2) whereas Chinese teachers paid the same level of attention to the teacher's explanations for both lessons (M_{CH} = 4.8). Slight differences were found between U.S. and Chinese teachers' level of attention to the students and classroom environment (Table 2). U.S. teachers paid more attention to the students ($M_{U.S.}$ = 3.7) and classroom environment ($M_{U.S.}$ = 3.3) than the Chinese teachers (M_{CH} = 3.2 and M_{CH} = 2.3 correspondently). However, the differences in average scores reported for the teacher-directed lesson (Table 2.2) was smaller than the differences found in the student-centered lesson (Table 2.1).

Table 2.2 Differences between U.S. and Chinese teachers' level of attention to components of teacher-directed lesson (HK Classroom)

Components	U.S. Median	Chinese Median	*U*	*r*
Students	4.0	3.0	9	0.32
Teacher Explanations	4.5	5.0	11	0.36
Classroom Management	4.0	2.5	0**	0.84
Teaching Material	2.0	4.5	1.5**	0.79
Classroom Environment	3.3	2.3	9	0.47

Note. *r* = effect size

*** p <.05** **** p <.01**

Qualitative findings: U.S. and Chinese teachers' descriptions of noteworthy aspects in the teacher-directed lesson (HK classroom)

U.S. teachers paid the most attention to the *teacher-directed* aspects of the teachers (100%), the teacher's *limited use of praise* (100%), and the *highly-structured* nature of the lesson (100%). Chinese teachers also noticed the *teacher-directed* nature of the lesson (100%) and the teacher's level of *subject matter knowledge* (100%). Five Chinese teachers (83%) attend to students' learning outcomes as indicated by their written solutions (*product-oriented*).

RQ1b. How do U.S. and Chinese teachers interpret these lessons?

For the student-centered lesson, it was expected that these U.S. teachers will interpret and evaluate the student-centered lesson more highly than the Chinese teachers. For the Chinese teachers, it was expected that they would interpret and evaluate the teacher-directed lesson more positively than the U.S. teachers (H2). However, U.S. and Chinese teachers' evaluation ratings were very similar for both lessons (Tables 3 and 4). Both groups of teachers rated the teaching method higher for the student-centered lesson but rated students' understanding higher for the

teacher-directed lesson. In their responses to the open-ended questionnaire, the U.S. teachers made more interpretations of the teachers' tone and students' verbalizations, whereas Chinese teachers made more interpretations based on students' answers.

Quantitative findings: comparing U.S. and Chinese teachers' evaluations of the student-centered lesson (U.S. classroom)

U.S. and Chinese teachers' evaluations of the lesson were highly similar, as shown in Table 3. When asked to evaluate the quality of the teaching on a 5-point Likert scale (1 = Very Poor, 5 = Very Good), both groups reported an average rating of "good" (M = 3.8). When asked to rate the quality of the students' mathematical understanding on a 5-point scale (1 = Very Poor, 5 = Very Good), both groups reported an average score of "fair" (M = 3.1).

Table 2.3. U.S. and Chinese teachers' evaluations of the student-centered lesson (U.S. Classroom)

1= Very poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very good

	U.S. Mean	Chinese Mean	Difference	Mean
Teaching Evaluation	3.7	3.8	-0.1	3.8
Students' understanding	3.0	3.2	-0.2	3.1

Qualitative findings: U.S. and Chinese teachers' interpretations of the student-centered lesson (U.S. classroom)

Teachers' interpretations of observed events were elicited through open-ended questions such as "Why did that stand out to you?" and "What did you think about [X]?". In describing their interpretations of the American teacher's instructional style, all six U.S. teachers addressed the teacher's tone (100%) whereas only one Chinese teacher commented on the teacher's tone. U.S. and Chinese teachers also differed in *how* they interpreted the teacher's tone. Four U.S.

teachers interpreted the teacher's tone negatively. U.S. teachers' interpretations of the teacher's tone reflect their orientation towards *generous praise,* which is rooted in the belief that teachers should actively encourage their students regardless of their ability levels and whether they are correct or incorrect. For example, U.S.4 critiqued the American teacher's attitude towards one of his students:

> *"So there's one kid who's making the graph wrong and not using the graph paper lines. He just gets so annoyed with the kid. I wouldn't make the kind of snarky disparaging remarks that he did."* (U.S.4 3)

In contrast, Chinese teachers interpreted the American teacher's tone and behavior as being friendly and relaxed. Several Chinese teachers remarked upon the contrast between the American teacher's presence with mainland Chinese teachers' presence. One Chinese teacher commented favorably on the friendliness of the American teacher:

> *"The posture of the teacher when he was teaching the class was very kind and natural. Because you know, we might be more strict when we're teaching, and then his class doesn't seem so strict, and it felt like he was discussing with the students."* (CH5)

However, four Chinese teachers commented that the American teacher was *too* friendly and relaxed with his students (66%). This is consistent with the "East Asian" feature of *Limited Praise*, which reflects the belief that teachers should limit their praise for exceptional work and talent. When asked about their impressions of the American teacher's instructional style, all 6 teachers (100%) expressed their support for the American teacher's facilitation of student-led inquiry (*child-centeredness*). However, Chinese teachers (100%) felt that the lack of emphasis on supporting student learning outcomes was a point of weakness. This is consistent with a *product-oriented* approach to evaluation. For example, one Chinese teacher remarked that the American teacher seems to prioritize building students' confidence at the expense of emphasizing mastery of learning outcomes:

> *"In the United States lesson, there's a problem that no matter what the students say, the teacher will cut you some slack and give you a "step down". He makes all of the students feel happy. His purpose is to give the students confidence. The students' mastery of this lesson is actually not his purpose. He seems to care more about getting the students interested in the class. It's like "You can't think that I going to be very strict with you because it will hurt you and discourage you." This is the feeling I get."* (CH4)

When U.S. and Chinese teachers were asked to share evaluate student understanding in the student-centered lesson, the U.S. teachers based their evaluations on the American teacher's classroom management skills and the clarity of his directions (*general pedagogical knowledge*) (100%); they also made many judgments of *individualized learning* practices (100%). The Chinese teachers based their evaluations of student learning on students' written work and verbal responses to the teacher's questions (100%). These statements are consistent with a *product-orientated* approach to evaluation. The Chinese teachers' interpretive comments also frequently mentioned the students' level of *intrinsic motivation* (100%).

Quantitative findings: comparing U.S. and Chinese teachers' evaluations of the teacher-directed lesson (HK classroom)

U.S. and Chinese teachers' evaluations of the teacher-directed lesson were highly similar (Table 4). When asked to evaluate the quality of the teaching on a 5-point Likert scale (1 = Very Poor, 5 = Very Good), both groups reported an average rating of "fair" (M = 3.3). When asked to rate the quality of the students' mathematical understanding on a 5-point scale (1 = Very Poor, 5 = Very Good), both groups reported an average score of "Good" (M = 3.9). It is important to note that neither lesson video featured summative assessments (e.g., quizzes, tests) of student learning nor were the participants provided any additional information about student grades, school rankings, etc. Thus, the participants' evaluations of students' understanding were based solely on their interpretations of the classroom events and interactions in each lesson.

Table 2.4. U.S. and Chinese teachers' evaluations of the teacher-directed lesson (HK Classroom)

1= Very poor, 2 = Poor, 3 = Fair, 4 = Good, 5 = Very good

	U.S. Mean	Chinese Mean	Difference	Mean
Teaching Evaluation	3.2	3.3	-0.1	3.3
Students' understanding	4.0	3.8	0.2	3.9

Qualitative findings: U.S. and Chinese teachers' interpretations of the teacher-directed lesson (HK classroom)

When asked to evaluate the Hong Kong students' understanding, nine teachers (5 U.S. and 4 Chinese) felt that student understanding was higher in the teacher-directed lesson. As one American teacher observes, "I feel like the Hong Kong lesson was more focused on student thinking, because I feel like the U.S. lesson was more focused on student doing." (U.S.4) However, five U.S. math teachers also said that they found it difficult to evaluate students' mathematical thinking in teacher-directed lesson due to the lack of verbal explanations. This indicates a *process-oriented* approach to evaluating student learning. In contrast, five Chinese teachers agreed that it was easier to gauge students' mathematical thinking in the teacher-directed lesson. The Chinese teachers felt that the best way to evaluate student learning was by inviting students to demonstrate and present their solutions. These statements are consistent with a *product-orientation.*

> *"The U.S. may pay more attention to this kind of exploration and open communication, while the Hong Kong classroom focuses more on how you present it. That is, you will see they have several classmates go to the blackboard to demonstrate what they've learned. In fact, this is the most intuitive way for teachers to understand how well the students have mastered what they've learned. However, in the United States, you may think that the child is very happy to talk and is very active, but if you ask him to solve a problem, he may immediately make a mistake. So obviously you feel that there are different expectations and the results are quite different."* (CH4)

> *"The students in the United States gave me the feeling that they're a bit uneven; the answers that they came up with made me feel quite unbearable."* (CH6)

U.S. and Chinese teachers critiqued the teacher-directed lesson for the lack of active engagement and participation from students, which indicates a shared preference for child-centered teaching. U.S. teachers showed mixed reactions when asked to discuss their impressions of the Hong Kong teachers' instructional style. For example, both U.S. and Chinese teachers felt that the Hong Kong teacher relied too heavily on giving explanations instead of facilitating student engagement (*child-centered).*

While all six U.S. teachers expressed that they found the Hong Kong teacher's tone to be too "harsh" and "abrasive" *(generous praise*), four U.S. teachers appreciated the teacher's classroom management skills (*general pedagogical knowledge*). All six Chinese teachers positively evaluated the Hong Kong teacher's explanations, which indicated a high degree of *subject matter knowledge*.

When asked to describe their instructional responses to both lessons, it was expected that the U.S. teachers' responses would include more stereotypically "Western" features, whereas Chinese teachers' responses would include more stereotypically "Eastern" features (H3). This was largely supported by teachers' responses to questionnaire items and interviews.

Qualitative findings: U.S. and Chinese teachers' instructional responses to the student-centered lesson (U.S. classroom)

U.S. teachers' instructional responses largely centered around improving *general pedagogical knowledge* (100%). U.S. teachers' instructional responses tend to focus on providing clearer directions and better distribution of classroom materials. U.S. teachers also offered instructional strategies that would engage students in further inquiry and discussion while reducing teacher guidance. These strategies are consistent with *child-centeredness* (100%) and *less-structured* lessons (83%).

In contrast, the Chinese teachers' instructional responses were more consistent with "Eastern" pedagogical features such as *teacher-directed* instruction (100%) and *highly-structured* lessons (100%). All six Chinese teachers felt that the student-directed lesson needed more direct guidance from the teacher and lacked sufficient content and structure. Five Chinese teachers (83%) also felt that the student-directed lesson needed to include a *whole class* teaching activity, such as calling each group to the board to present their answers or to lead a demonstration.

Qualitative findings: U.S. and Chinese teachers' instructional responses to the teacher-directed lesson (HK classroom)

U.S. and Chinese teachers offered instructional strategies to increase student participation. U.S. teachers' suggestions were consistent with *process-oriented* pedagogy, such as giving students opportunities to verbalize their thinking processes and to explore alternative solutions (100%). As a group, the U.S. teachers felt that the Hong Kong lesson was too "rigid" (U.S.5) and needed to be more *less-structured*, which would allow for more student discussions and interactions(100%). For Chinese teachers, increased participation means giving more

students opportunities to share and receive feedback on their written work with the rest of the class. This is consistent with a *whole-class teaching* approach (100%).

Both U.S. and Chinese teachers suggested ways to increase the Hong Kong students' *intrinsic* motivation. U.S. teachers emphasized motivating students by offering encouraging feedback and displaying more instructor enthusiasm, which is consistent with *generous praise* (100%). All six (100%) Chinese teachers commented that the teacher needed to spark student interest by presenting novel questions, a type of pedagogical strategy commonly applied in *teacher-directed* instruction Moreover, five Chinese teachers (83%) proposed asking students to observe and discuss the abstract characteristics of the solution method. This approach is consistent with the stereotypically East Asian feature of developing students' conceptual understanding through *abstract representations*.

RQ2. To what extent are U.S. and Chinese teachers' noticing in agreement with their pedagogical beliefs (T-PB)? To what extent are U.S. and Chinese teachers' noticing in agreement with their perceptions of cultural pedagogical beliefs (TP-CPB) about mathematics education?

The initial hypothesis was that U.S. and Chinese teachers' noticing would align more with their perceived cultural pedagogical beliefs (TP-CPB). Findings for H4 were inconclusive due to minimal variation between U.S. and Chinese teachers' overall T-PB and TP-CPB ratings. Both U.S. and Chinese teachers' average T-PB and TP-CPB scores showed minimal differences ($M_{U.S.-TPB}$ = 2.0, $M_{U.S.-TP-CPB}$= 2.1; $M_{CH.-TPB}$ = 2.3, $M_{U.S.-TP-CPB}$= 2.2). U.S. teachers' noticing scores ($M_{U.S.-TN}$= 2.0) were more closely matched to both teachers' pedagogical beliefs (T-PB) ($M_{U.S.-T-PB}$= 2.0) and teachers' perceptions of their culture's pedagogical beliefs (($M_{U.S.-TP-CPB}$= 2.1). Similarly, Chinese teachers' noticing scores (M_{CH-TN}= 1.9) were similarly aligned with their

perceptions of their culture's pedagogical beliefs (TP-CPB) ($M_{CH\text{-}TP\text{-}CPB}$= 2.2) and their own pedagogical beliefs (T-PB) ($M_{CH\text{-}T\text{-}PB}$= 2.3). Overall, these findings indicate that teacher noticing patterns are generally consistent with their reported personal and cultural beliefs.

However, when teachers' noticing and belief scores are separated by "Western" and "Eastern" features, teacher noticing patterns and beliefs seem to diverge. U.S. teachers' noticing scores were most closely matched to their pedagogical beliefs (T-PB) scores for "Western" features ($M_{U.S.\text{-}TN}$= 2.4, $M_{U.S.T\text{-}PB}$= 2.3). U.S. teachers' high levels of noticing for "Western" features corresponded with the higher levels of agreement in their pedagogical belief ratings. U.S. teachers' noticing scores for "Eastern" features were somewhat lower than their perceptions of cultural pedagogical belief ratings ($M_{U.S.\text{-}TN}$= 1.5, $M_{U.S\text{-}TP\text{-}CPB}$= 2.1). Chinese teachers' noticing scores were more closely matched to their beliefs scores for "Eastern" features ($M_{CH.\text{-}TN}$= 2.4, $M_{CH\text{-}T\text{-}PB}$= 2.2, $M_{CH\text{-}TP\text{-}CPB}$= 2.3). However, Chinese teachers' noticing (TN) scores for "Western" features was considerably lower compared to the level of agreement with "Western" features indicated in their belief ratings ($M_{CH.\text{-}TN}$= 1.3, $M_{CH\text{-}T\text{-}PB}$= 2.5, $M_{CH\text{-}TP\text{-}CPB}$= 2.1).

U.S. Teachers' Noticing Patterns and Pedagogical Beliefs

Overall, U.S. teachers' noticing scores were slightly more closely matched to their pedagogical beliefs (T-PB) than their perceptions of cultural pedagogical beliefs (TP-CPB). U.S. teachers' noticing scores were most aligned with their pedagogical beliefs (T-PB) for "Eastern" features (MD = 0.3); larger differences were found between U.S. TN scores and U.S. TP-CPB scores for "Western" features (MD= 0.8).

Similarities and differences between U.S. teachers' noticing and beliefs. U.S. teachers' noticing (TN) scores were similar to their pedagogical beliefs (T-PB) (MD $\leq$ 0.1) scores on seven out of 20 SPFs: *individualized learning* ($M_{U.S.\text{-}TN}$= 2.8, $M_{U.S.\text{-}TPB}$= 2.7), *intrinsic*

motivation ($M_{U.S.-TN}$= 2.0, $M_{U.S.-TPB}$= 2.1), *product-orientation* ($M_{U.S.-TN}$= 1.7, $M_{U.S.-TPB}$= 1.8), *subject matter knowledge* ($M_{U.S.-TN}$= 1.2, $M_{U.S.-TPB}$= 1.1), *extrinsic motivation* ($M_{U.S.-TN}$= 2.3, $M_{U.S.-TPB}$= 2.3), *studying hard* ($M_{U.S.-TN}$= 2.2, $M_{U.S.-TPB}$= 2.2), and *abstract representation* ($M_{U.S.-TN}$= 2.3, $M_{U.S.-TPB}$= 2.4). In contrast, U.S. teachers' noticing (TN) scores were similar to their perceived cultural pedagogical beliefs (TP-CPB) (MD ≥ 0.1) on only two out of 20 SPFs: *intrinsic motivation* ($M_{U.S.-TN}$= 2.0, $M_{U.S.-TPCPB}$= 2.0) and *studying hard* ($M_{U.S.-TN}$= 2.2, $M_{U.S.-TPCPB}$ = 2.1).

U.S. teachers' noticing (TN) scores differed from their pedagogical beliefs (T-PB) (MD ≥ 1.0) scores on three out of 20 SPFs: *concrete representation* ($M_{U.S.-TN}$= 1.2, $M_{U.S.-TPB}$ = 2.3), *pleasurable learning* ($M_{U.S.-TN}$= 1.0, $M_{U.S.-TPB}$ = 2.1), and *generous praise* ($M_{U.S.-TN}$= 3.0, $M_{U.S.-TPB}$ = 2.3). U.S. teachers' noticing (TN) scores diverged from their perceived cultural pedagogical beliefs (TP-CPB) (MD ≥ 1.0) on six out of 20 SPFs: *concrete representation* ($M_{U.S.-TN}$= 1.2, $M_{U.S.-TPCPB}$ = 2.4), *pleasurable learning* ($M_{U.S.-TN}$= 1.0, $M_{U.S.-TPCPB}$ = 2.3), *child-centeredness* ($M_{U.S.-TN}$= 3.0, $M_{U.S.-TPCPB}$ = 1.9), *general pedagogical knowledge* ($M_{U.S.-TN}$= 3.0, $M_{U.S.-TPCPB}$ = 2.3), *highly-structured* ($M_{U.S.-TN}$= 1.0, $M_{U.S.-TPCPB}$ = 2.0), and *memorizing to understand* ($M_{U.S.-TN}$= 1.2, $M_{U.S.-TPCPB}$ = 2.5).

Chinese Teachers' Noticing Patterns and Pedagogical Beliefs

Chinese teachers' noticing scores were slightly closer to their perceptions of cultural pedagogical beliefs (TP-CPB) than their own pedagogical beliefs (T-PB). Chinese teachers' noticing scores were most similar to their perceived cultural pedagogical beliefs (TP-CPB) for "Eastern" features (MD = 0.4); larger differences were found between Chinese TN scores and T-PB scores for "Western" features (MD= 1.2).

Chinese teachers' noticing (TN) scores were most similar to their pedagogical beliefs (T-PB) (MD ≤ 0.1) scores on only one out of 20 SPFs: *product-orientation* ($M_{CH\text{-}TN}$= 2.8, $M_{CH\text{-}TPB}$ = 2.9). The level of agreement was higher for Chinese TN and TP-CPB, aligning on (MD ≤ 0.1) on four out of 20 SPFs: *child-centeredness* ($M_{CH\text{-}TN}$= 1.8, $M_{CH\text{-}TPCPB}$ = 1.8), *product-orientation* ($M_{CH\text{-}TN}$= 2.8, $M_{CH\text{-}TPCPB}$ = 2.7), *subject matter knowledge* ($M_{CH\text{-}TN}$= 2.0, $M_{CH\text{-}TPCPB}$ = 1.9) (MD = 0.1), and *studying hard* ($M_{CH\text{-}TN}$= 2.8, $M_{CH\text{-}TPCPB}$ = 2.9).

Chinese teachers' noticing (TN) scores differed from their pedagogical beliefs (T-PB) (MD ≥ 1.0) scores on eight out of 20 SPFs: *process-orientation* ($M_{CH\text{-}TN}$= 1.7, $M_{CH\text{-}TPB}$ = 2.8), *concrete representation* ($M_{CH\text{-}TN}$= 0.5, $M_{CH\text{-}TPB}$ = 2.8), *pleasurable learning* ($M_{CH\text{-}TN}$= 1.0, $M_{CH\text{-}TPB}$ = 2.4), *individualized learning* ($M_{CH\text{-}TN}$= 1.0, $M_{CH\text{-}TPB}$ = 2.4), *memorizing to reinforce* ($M_{CH\text{-}TN}$= 1.3, $M_{CH\text{-}TPB}$ = 2.8) (MD = 1.5), *generous praise* ($M_{CH\text{-}TN}$= 1.3, $M_{CH\text{-}TPB}$ = 2.4) (MD = 1.1), *general pedagogical knowledge* ($M_{CH\text{-}TN}$= 1.2, $M_{CH\text{-}TPB}$ = 2.8) (MD = 1.6) , and *extrinsic motivation* ($M_{CH\text{-}TN}$= 1.3, $M_{CH\text{-}TPB}$ = 2.3) (MD = 1.0). Chinese teachers' noticing (TN) scores were most different from their perceived cultural pedagogical beliefs (TP-CPB) (MD ≥ 1.0) on four out of 20 SPFs: *process orientation* ($M_{CH\text{-}TN}$= 1.7, $M_{CH\text{-}TPCPB}$ = 2.9) (MD = 1.2), *concrete representation* ($M_{CH\text{-}TN}$= 0.5, $M_{CH\text{-}TPCPB}$ = 2.5) (MD= 2.0), *memorizing to reinforce* ($M_{CH\text{-}TN}$= 1.3, $M_{CH\text{-}TPCPB}$ = 2.3) (MD = 1.0), and *general pedagogical knowledge* ($M_{CH\text{-}TN}$= 1.2, $M_{CH\text{-}TPCPB}$ = 2.5) (MD = 1.3).

Discussion

The primary purpose of this study was to compare and contrast how U.S. and Chinese teachers attend, notice, and interpret two different instructional styles (student-centered and teacher-directed). The findings supported the hypothesis that U.S. and Chinese teachers attend to instructional events that are consistent with "Western" and "Eastern" SPFs (H1). However, U.S.

and Chinese teachers' evaluations of both lessons were very similar (H2). The student-centered lesson was evaluated more favorably by both groups. Yet, both U.S. and Chinese teachers felt that students' understanding was higher in the teacher-directed lesson. In agreement with (H3), U.S. and Chinese teachers tend to respond in ways consistent with their respective stereotypical pedagogical features (SPFs). The U.S. teachers' instructional responses were aligned with "Western" SPFs while the Chinese teachers' instructional responses mainly reflected "Eastern" SPFs.

The secondary aim was to compare teachers' noticing scores to their pedagogical beliefs (T-PB) and their perceptions of cultural pedagogical beliefs (TP-CPB) about mathematics education. Since the differences between U.S. and Chinese teachers' T-PB and TP-CPB ratings were minimal, the findings are inconclusive. However, it is clear that U.S. teachers' are more adept at noticing "Western" features, which is consistent with the higher levels of agreement with "Western" pedagogy reported in the pedagogical beliefs ratings (T-PB); however, Chinese teachers' showed lower levels of noticing for "Western" features despite reporting high levels of agreement with "Western" pedagogy in their pedagogical belief ratings (T-PB). Chinese teachers' noticing patterns scored higher on "Eastern" features, which is consistent with the higher levels of agreement with "Eastern" pedagogy as reported by their TP-CPB ratings.

Culturally-Shaped Noticing? Significant Differences in U.S. and Chinese Teachers' Attentional Patterns Across Both Lessons Suggest Cultural Influence on Noticing

Comparative studies point to group-level differences in Western and Eastern teachers' noticing patterns . Authors of these studies typically link their interpretations of these results to the distinctions between "Western" and "Eastern" pedagogy, particularly with respect to Eastern teachers' greater attention to mathematics content and students' mathematical thinking compared

to their Western counterparts. One question is whether this attentional pattern holds across different lessons and whether these patterns are consistent with cultural stereotypes.

The findings suggest cultural differences in U.S. and Chinese teachers' noticing patterns. For instance, both the survey and interview data on the *attending* facet of teacher noticing seems to offer support for the *general pedagogical knowledge* ("Western) vs. *subject matter knowledge* ("Eastern") dichotomy. The Chinese teachers paid significantly more attention to teachers' explanations and teaching materials for both lessons, while U.S. teachers paid significantly more attention to classroom management for both lessons (Tables 1 and 2). These results are broadly consistent with recent cross-cultural research on teachers' attentional patterns (Bork & Zhu, 2022; McIntyre et al., 2017; Yang et al., 2019). Teachers from East Asian countries paid more attention to mathematics instruction and content (e.g., explaining a mathematical concept, analyzing mental processes, and identifying task types, mathematical competencies, and students' mathematical ideas) than their Western counterparts. On the other hand, US teachers focus more on general pedagogy (e.g. classroom management, motivation, student participation, and assessment) than Eastern teachers.

It is worth noting that U.S. and Chinese teachers' noticing attending patterns seem to shift between the two lessons; however, these within-group shifts did not impact the significant between-group differences reported in the survey data (Tables 1 and 2). U.S. teachers paid considerably more attention to the teacher's explanations in the teacher-directed lesson (*MU.S.* = 4.2) than in the student-centered lesson (*MU.S.* = 3.2). In the interviews, the U.S. teachers paid a lot of attention to "Eastern" SPFs such as *teacher-directed* instruction, *limited praise,* and *highly-structured* lesson plans when observing the Hong Kong lesson; when they observed the

American lesson, they paid the most attention to "Western" features such as *general pedagogical knowledge* and *generous praise*.

U.S. teachers paid more attention to the teacher and teaching materials in the HK lesson than the U.S. video because these instructional methods differed from their everyday practice. These differences (e.g., the teachers' stern tone, students' level of respect, teachers' control) caught their attention and prompted further reflection and examination of their own practices. In previous studies, it has been reported that watching lessons from countries that are culturally different seems to spark greater discussion of one's own cultural values and practices (Tobin et al., 2009; Schwarts & Karsenty, 2020).

Similar shifts were found in Chinese teachers' the qualitative analysis of their *attending* process, but not the quantitative data. The survey data shows that the Chinese teachers' attention stayed the on teachers' explanations and teaching materials for both lessons; however, the Chinese teachers' qualitative data shows that they paid more attention to the Western SPFs (*child-centeredness* and *individualized learning)* in the student-lesson while attending to the Eastern SPFs *(teacher-directedness,* s*ubject matter knowledge, product-orientation*) in the teacher-directed lesson. One reason the qualitative data on Chinese teachers' attending patterns do not seem to correspond with the survey data may be due to the differences in word choice. The open-ended questionnaire item asks teachers to describe what caught their attention ("In the video you just watched, what stood out to you?"). In contrast, the survey item asks teachers to estimate how much time they focused on each aspect of the classroom ("When you were observing the lesson, how much time did you spend paying attention to each of the following aspects?"). It may be that, for the Chinese teachers, the Western SPFs initially caught their eye

but they continued to focus their gaze on the aspects that were more important (i.e., teachers' explanations and teaching materials).

U.S. and Chinese Teachers Prefer Teacher-Directed Instruction for Student Learning

One fascinating insight from this study is that while both U.S. and Chinese teachers rated the teaching quality higher in the student-centered lesson, both groups felt that students' understanding was higher in the teacher-directed lesson (Table 7). This is an example of the "Chinese learner paradox," which refers to the outstanding performance of East Asian students despite being in a teacher-directed learning environment (Kember, 2016; Mok, 2006; Watkins & Biggs, 1996). This phenomenon baffles researchers because a teacher-directed learning environment is widely considered incompatible with deep learning (Ryan & Louie, 2007; Tan, 2011). And yet, East Asian countries – which includes China, Singapore, Taiwan, South Korea, and Japan – have consistently obtained high scores on international achievement tests, particularly in mathematics (PISA, TIMSS).

The perception that students learn more in a teacher-directed learning environment may explain why East Asian educators may be more reluctant to practice student-centered teaching. Indeed, studies show that East Asian classrooms have maintained teacher-centered pedagogical practices despite student-centered reform efforts (Kember, 1996; Kim, 2018; 2019). In our study, several Chinese teachers critiqued the student-centered lessons' relatively weak emphasis on student learning. CH4 was concerned that too much emphasis was placed on "making students happy," which undermined the lesson's focus on content mastery. Similarly, CH3 expressed that she found the student-centered lesson "quite unbearable" to watch due to the significant errors in students' mathematical thinking. These Chinese teachers' concerns about the inefficacy of student-centered learning practices for obtaining higher learning outcomes are not unfounded.

Lau & Lam's (2017) analyses of teaching practices and PISA outcomes found that teacher-directed instruction was positively associated with higher test performance. Nearly all top-scoring countries had a "high frequency of teacher-directed instruction facilitated by more or less authoritative class discussion" (Lau & Lam, 2017, p. 2144). Conversely, certain student-centered practices such as "interactive investigation"— were negatively associated with PISA scores.

It is perhaps unsurprising to find these critiques echoed in the Chinese teachers' comments. What *is* notable, however, is that even the U.S. teachers observed that "students learned more" (U.S.2) in the teacher-directed lesson. The U.S. teachers appreciated many aspects of the teacher-directed lesson– namely, the students' respectful behavior and the teacher's level of control over the classroom. This should not be taken to mean that U.S. teachers *preferred* the teacher-directed lesson. On the contrary, the Hong Kong teacher's instructional style was roundly criticized for being "too harsh" by all six U.S. teachers. Nevertheless, five U.S. teachers perceived the Hong Kong students' mathematical understanding was higher than the U.S. students'. Even more curious is that the U.S. teachers did not attribute students' higher understanding to the teacher's instructional style; instead, these strengths were attributed to the students' respect for the teacher's authority rather than the instructional method.

Implications for Practice

Challenging Misconceptions about East Asian Pedagogy and Student-Centered Teaching

Contrary to popular beliefs about East Asian pedagogy, these Chinese teachers paid attention to important aspects of student-centered learning. In fact, the results of this study suggest that certain "East Asian" features can support student-centered teaching, particularly regarding noticing and responding to students' mathematical thinking. "Western" and "East Asian" features can support teachers' noticing of different instructional aspects. "Western" pedagogical features such as *general pedagogical knowledge, generous praise, child-centeredness, individualized learning,* and *process-orientation* tend to support teachers' noticing of the classroom environment; "East Asian" features such as *product-orientation, teacher-directed instruction, subject matter knowledge,* and *abstract representation* tend to support teachers' noticing of mathematics instruction. Both are essential components of a student-centered mathematics classroom: a supportive learning environment (classroom environment) coupled with an emphasis on meaningful engagement with mathematics (mathematics instruction) (Walters et al., 2014).

The results of this study offer important implications for the design and development of professional development programs aimed at improving student-centered noticing in cross-cultural contexts. A model of student-centered pedagogy that draws upon the strengths of both cultural paradigms can be helpful to Western and East Asian educators. Determining that a teacher's noticing patterns seem to be rooted in SPFs opens the way to designing professional development tasks for him or her that can target culturally-specific areas of strengths or weaknesses. For instance, a noticing program for U.S. educators might target their ability to *attend* , *interpret*, and *respond* to pedagogical features that support students' sensemaking

around mathematics (Mathematical Thinking). Conversely, Chinese educators may need more support in *attending to*, *interpreting*, and *responding* with features that establish a supportive learning environment (Class Environment) (Bork & Zhu, 2022).

Implications for Research

Linking Teachers' Professed Beliefs to Behavior

An important methodological implication is that studies of what teachers believe should be accompanied by measures of what they do. In this study, I examined teachers' noticing (attending, interpreting, and responding) as an indicator of teacher behavior**.** A researcher can better capture what drives the teacher's noticing by triangulating task-based measures of teacher noticing with independent measures of personal and cultural pedagogical beliefs. More importantly, exploring the connections and tensions between what teachers notice and what they believe provides a deeper understanding of the factors that inform teacher practice.

The study findings highlight the discrepancy between teachers' professed beliefs and their noticing, particularly for Chinese teachers. Chinese teachers' noticing appear to be largely influenced by "East Asian" SPFs despite high levels of agreement with "Western" SPFs according to their pedagogical beliefs (T-PB). Chinese teachers' noticing appear to be primarily influenced by "East Asian" SPFs despite high levels of agreement with "Western" SPFs according to their pedagogical beliefs (T-PB). Thus, for Chinese teachers, implicit cultural beliefs play a more prominent role in shaping what and how they notice. Future research on East Asian teachers' pedagogical beliefs and practices should consider these differences.

Limitations

This study largely confirms the findings from previous cross-cultural comparisons of Western and East Asian teachers' noticing patterns (e.g., Dreher et al., 2021; Yang et al., 2019;);

however, these findings may not apply to the greater population of U.S. and Chinese teachers due to the small sample size and sampling procedure. Similarly, the findings on U.S. and Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB) and pedagogical beliefs (T-PB) may not reflect all teachers in these two countries. Future studies should consider involving more teachers from more geographic regions and teachers from different grade levels. Furthermore, due to the focus on exploring the connections between teachers' noticing and beliefs, this study did not include measures of teacher practice. The additional classroom observations in future studies will provide a deeper understanding of how culture influences what teachers believe, perceive, and practice.

Conclusion

The findings from this study indicate that certain "Western" and "Eastern" stereotypical pedagogical features (SPFs) continue to shape how and what teachers notice. Our findings show that U.S. and Chinese teachers' noticing patterns were markedly distinct despite holding similar personal pedagogical beliefs (T-PB) about teaching and learning. Group differences were observed in how the American and Chinese teachers attended, interpreted, and responded to both the student-centered and teacher-directed lessons. Moreover, the relative influence of stereotypically "Western" and "Eastern" features seems to be different for U.S. and Chinese teachers. U.S. teachers' noticing patterns and pedagogical beliefs (T-PB) both aligned with "Western" features. In contrast, the Chinese teachers' noticing patterns aligned more with "Eastern" features, despite reporting higher agreement with "Western" pedagogy in their pedagogical beliefs (T-PB) belief ratings. Future researchers should consider and assess for implicit cultural influences, particularly in countries that have undergone major cultural and political shifts in recent decades.

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CONCLUSIONS

It is widely reported that certain characteristics— stereotypical pedagogical features (SPFs)— are associated with teaching practices from Western and East Asian cultural contexts. These stereotypical pedagogical features (SPFs) shape what teachers from these cultural contexts believe about how mathematics should be taught and learned. When researchers observe differences in what Western and East Asian educators believe or notice, it is often related to distinctions between "Western" and "Eastern" cultures. To investigate this assumption, investigate the extent to which U.S. and Chinese teachers' beliefs and noticing conform to these cultural stereotypes. Below, I give a brief overview of the findings that emerged from each paper, followed by a discussion of key implications.

Overview of Findings

Paper one investigates whether current U.S. and Chinese teachers' pedagogical beliefs (T-PB) and perceptions of their culture's pedagogical beliefs (TP-CPB) are consistent with cultural stereotypes about "Western" and "Eastern" pedagogy. The findings show that U.S. teachers' *personal* pedagogical beliefs (T-PB) matched more closely to "Western" stereotypes; meanwhile, Chinese teachers' perceptions of their *culture's* pedagogical beliefs (TP-CPB) matched more closely to "Eastern" stereotypes. Interestingly, interview data showed that both U.S. and Chinese teachers considered their personal beliefs about teaching and learning to be more student-centered and progressive than their culture's approach to teaching, which is described as more teacher-directed and traditional (Malaty, 1997). This is supported by the survey data, which indicates that both U.S. and Chinese teachers' pedagogical beliefs (T-PB) ratings showed higher agreement with "Western" SPFs compared to their perceptions of their culture's pedagogical beliefs (TP-CPB), which agreed more with "Eastern" SPFS.

Paper two investigates whether U.S. and Chinese teachers' noticing patterns are more consistent with their personal pedagogical beliefs (T-PB) or perceptions of their culture's pedagogical beliefs (TP-CPB). It is widely theorized that teachers' cultural beliefs may shape what teachers notice even more so than their personal beliefs about teaching and learning (CITE). Therefore, the primary purpose of this study is to examine the relative influence of personal and cultural beliefs on what teachers notice. It was initially anticipated that U.S. and Chinese teachers' noticing patterns would be more closely matched to their perceptions of cultural pedagogical beliefs (TP-CPB). To investigate this assumption, I compared U.S. and Chinese teachers' noticing (TN) scores from a video-cued noticing task to their self-reported survey ratings for their personal and cultural beliefs. Due to minimal variation between teachers' pedagogical beliefs (T-PB) and perceived cultural pedagogical beliefs (TP-CPB), the findings were inconclusive. However, U.S. teachers' noticing (TN) and pedagogical beliefs (T-PB) were most consistent with "Western" features whereas Chinese teachers' noticing (TN) and perceived cultural beliefs (TP-CPB) were most consistent with "Eastern" features. This suggests that the influence of implicit cultural values and norms about teaching and learning—stereotypical pedagogical features—are more clearly reflected in U.S. teachers' *personal* views (T-PB); for Chinese teachers, these cultural influences are more clearly reflected in their perceptions of their *culture's* views (TP-CPB).

Discussion

Preserved and Subverted Cultural Stereotypes about "Western" and "Eastern" Pedagogy

Scholars argue that Western and East Asian cultures hold different philosophies regarding teaching and learning, particularly about mathematics (Leung, 2001; Leung et al., 2006; Tweed & Lehman, 2002). "Western" pedagogical approaches are widely considered to be

more student-centered, whereas "Eastern" pedagogy is often described as being more teacher-directed (Bryan et al., 2007). "Western" pedagogical approaches are widely considered to be more student-centered, whereas "Eastern" pedagogy is often described as being more teacher-directed (Bryan et al., 2007). Cross-cultural researchers often rely on these stereotypical characterizations of "Western" and "Eastern" pedagogy to interpret differences in teacher practice. However, recent cross-cultural studies suggest that current U.S. and Chinese teachers' pedagogical beliefs may be shifting away from the "Western" and "Eastern" stereotypes identified in earlier research (Ryan & Louie, 2007; Bryan et al., 2007).

The findings from Paper One indicate that teachers' pedagogical orientations (as indicated by their personal pedagogical beliefs and perceptions of their culture's pedagogical beliefs) continue to conform to *some* cultural stereotypes. Overall, quantitative data on U.S. and Chinese teachers' beliefs (both T-PB and TP-CPB) appear to conform to cultural stereotypes along three out of ten dimensions: *lesson structure* (less-structured vs. highly-structured), *class structure* (individualized learning vs. whole class teaching), and *teaching method* (child-centered vs. teacher-directed). It is important to note that group differences along the *teaching method* dimension were found in the interview data but not in the surveys.

U.S. and Chinese teachers' noticing (TN) scores appear to be more aligned with cultural stereotypes than their beliefs. U.S. and Chinese teachers' noticing patterns conformed to cultural stereotypes along five out of ten dimensions: *evaluation* (process-oriented vs. product-oriented), *teacher expertise* (general pedagogical knowledge vs. subject matter knowledge), *teaching method* (child-centered vs. teacher-directed), *lesson structure* (less-structured vs. highly-structured), and *class structure* (individualized learning vs. whole class teaching). Teachers' noticing (TN) patterns appear to contradict their self-reported belief ratings on some features. For

example, the Chinese teachers' noticing (TN) patterns scored high on *teacher-directedness* despite reporting lower agreement on their T-PB and TP-CPB ratings.

The findings from Paper One identified two dimensions in which U.S. and Chinese teachers' beliefs subverted their respective cultural stereotypes: *rote learning* (memorizing to reinforce vs. memorizing to understand) and *motivation* (intrinsic vs. extrinsic).). U.S. teachers' beliefs showed higher agreement with "Eastern" features such as "memorizing to understand" and "extrinsic motivation." In contrast, Chinese teachers agreed more with their "Western" counterparts: "memorizing to reinforce" and "intrinsic motivation." However, the teacher noticing findings did not fully align with these results. For the noticing task, both U.S. and Chinese rarely made statements related to the *rote learning* dimension. This may be because the features related to this dimension are not readily observable. Regarding teacher noticing along the *motivation* dimension, both U.S. and Chinese teachers scored higher on *intrinsic* and lower on *extrinsic* motivation.

These study results indicate that "Western" and "Eastern" SPFs continue to shape current teachers' beliefs and noticing patterns. But the influence of these culturally-rooted features are taken up in different ways. For the U.S. teachers, these "Western" SPFs are adopted as part of their personal belief systems (T-PB) whereas the Chinese teachers perceive "Eastern" SPFs as part of the broader cultural expectations for teaching and learning. For both groups, teachers' noticing patterns seem to match more closely with their respective cultural stereotypes than their beliefs.

Chinese Teachers Hold "Western"-oriented Beliefs While Displaying "Eastern"-oriented Noticing

The apparent contradiction between Chinese teachers' "Western"-oriented pedagogical beliefs (T-PB) with their tendency to respond with "Eastern" instructional features is particularly

notable. One explanation for this is that Chinese mathematics educators do not approach "student-centered teaching" in the same way as Western cultures. In Western research, teachers elicit students' mathematical thinking by directly asking students to reason and justify their methods (Ding & Dominguez, 2016; Hill et al. 2010). In contrast, Chinese teachers gauge students' mathematical thinking using instructional activities, such as designing exercises with differing levels of complexity (Marton & Booth, 2013). In this way, Chinese educators determine students' mathematical thinking and knowledge by observing their ability to solve multiple problems (Huang & Leung, 2004).

Taken together, U.S. and Chinese teachers' noticing (TN) appear to support several dichotomies: general pedagogical knowledge vs. subject matter knowledge, teacher-directed vs. child-centered, process vs. product-orientation, and limited vs. generous praise – even as teachers' professed pedagogical beliefs (T-PB) seem to contradict them. Some features appear less salient across teachers' noticing, making it difficult to find support for these dichotomies. For example, we found few noticing statements related to concrete representations, pleasurable learning, memorizing to reinforce, and memorizing to understand for both groups. One dichotomy– extrinsic vs. intrinsic motivation– appears to be reversed, with Chinese teachers' noticing and beliefs scoring higher than U.S. teachers'.

Teacher Noticing Seems to be More Influenced by Cultural Stereotypes than their Beliefs

Our findings suggest that teachers' noticing patterns are more consistent with stereotypical pedagogical features (SPFs) than their pedagogical beliefs (T-PB) or perceptions of cultural pedagogical beliefs (TP-CPB). U.S. teachers' noticing (TN) patterns scored *higher* on "Western" SPFs ($M_{U.S.-TN}$= 2.4) than their pedagogical beliefs ($M_{U.S.T-PB}$= 2.3) or their perceptions of their culture's pedagogical beliefs ($M_{U.S.TP-CPB}$= 2.0); at the same time, U.S.

teachers' noticing (TN) scored *lower* on "Eastern" SPFs ($M_{U.S.-TN}$= 1.5) than their T-PB and TP-CPB ratings ($M_{U.S.T-PB}$= 1.8 and $M_{U.S.TP-CPB}$= 2.1). Similarly, the Chinese teachers' noticing (TN) patterns scored higher on "Eastern" SPFs (M_{CH-TN}= 2.4) than their beliefs (M_{CHT-PB}= 2.2 and $M_{CHTP-CPB}$= 2.3) while scoring *considerably lower* on "Western" SPFs (M_{CH-TN}= 1.3) compared to their beliefs (M_{CHT-PB}= 2.5 and $M_{CHTP-CPB}$= 2.1).

This finding seems to challenge the prevailing argument that beliefs influence behavior (Kouabenan, 1998; Grieve, 1991; Anderson & Barrett, 2016). Given the argument that individuals' beliefs strongly affect their behavior, it was expected that these teachers' belief ratings (T-PB or TP-CPB) would show higher agreement with the stereotypical pedagogical features that were reflected in their noticing patterns. A possible explanation is that beliefs are difficult to assess through direct measures. An individual's belief system consists of both implicit and explicit views—self-reported surveys can offer a lens into one's *professed* beliefs which may or may not be congruent with their implicit views and biases. In this way, noticing patterns may provide a better indicator of the teachers' implicitly held beliefs, values, and expectations about mathematics education.

Limitations

An important limitation to note is that this data was collected post-pandemic. The participants had resumed in-person classes at the time of the data collection. However, it is important to consider the impact of the pandemic in shaping the teachers' responses to both the videos and questions. Notably, several of the US teachers (US2, US 4, and US 6) discussed how pandemic lockdowns had adversely impact their students' social and cognitive development, leading to an increase in disruptive behaviors in class. The Chinese teachers did not discuss the impact of the pandemic on instructional activities or student behavior.

Nevertheless, these findings suggest group characteristics that distinguish Chinese and US teachers' beliefs and noticing patterns. Future studies should be conducted to unpack the role in which the pandemic—and the vastly different national approaches to handling its spread—has affected US and Chinese teachers' pedagogical beliefs and behaviors.

This thesis did not set out to make claims about US and Chinese teachers' beliefs and noticing behaviors that are generalizable to the broader population. Nor are these findings intended to be applicable across other subject areas. Due to the domain-specific nature of this study, the findings point to key characteristics of US and Chinese teachers' beliefs and perceptions in the context of middle school mathematics. It is possible that future studies outside of mathematics education may identify discrepancies between teachers' professed beliefs and noticing patterns.

Implications

Contributions to Research

Investigating the influence of culture on teacher practice can be challenging for two reasons. One major issue for this area of research is that we need a more rigorous approach to defining and assessing "cultural influence". In both papers, a predetermined framework of 20 SPFs (10 "Western" and 10 "Eastern") was applied to identify the extent to which teachers' beliefs and noticing patterns conformed to cultural stereotypes.

The findings from these studies highlight the need for both implicit and explicit measures of cultural influence. In Paper 1, it was found that U.S. and Chinese teachers' perceptions of cultural pedagogical beliefs (TP-CPB), an explicit measure of cultural influence, did not match as closely to their respective cultural stereotypes as expected. In fact, U.S. teachers' TP-CPB showed slightly higher agreement with "Eastern" features *(*$M_{U.S.\text{-}TP\text{-}CPB}$= 2.1) than "Western" features ($M_{U.S.\text{-}TP\text{-}CPB}$= 2.0). While the Chinese teachers' TP-CPB did show higher agreement with "Eastern" features ($M_{CH\text{-}TP\text{-}CPB}$= 2.5) compared to "Western" features ($M_{CH\text{-}TP\text{-}CPB}$= 2.1), the difference was smaller than initially anticipated (*MD* = -0.4).

Based on these explicit measures of cultural influence, it would be reasonable to conclude that Western and East Asian teachers are more culturally similar than different. U.S. and Chinese teachers' high agreement with "Western" pedagogical features, as indicated on their teachers' pedagogical belief ratings (T-PB), seems to further support this conclusion. Based on the findings of Paper 1, it appears that Chinese teachers may be moving away from traditional "Eastern" features in favor of "Western" features such child-centered instruction, general pedagogical knowledge, and process-orientation. However, Paper 2 demonstrates that these

"Eastern" features continue to influence Chinese teachers' pedagogical behaviors in implicit ways, as indicated by their noticing patterns.

Future studies should consider combining direct assessments of perceived beliefs (both personal and cultural) with measures of implicit biases and behaviors. Applying an a priori framework, such as the *Features of Western and East Asian Mathematics* can provide a useful starting point for analyzing both explicit and implicit forms of cultural influence. However, future scholars should also consider revising certain cultural dichotomies that are not empirically supported by the data (i.e., intrinsic motivation vs. extrinsic motivation; memorizing to reinforce vs. memorizing to understand).

Implications for Theory

The findings from this study illustrate some limitations of the *Western and East Asian Features of Mathematics Education*. According to this framework, "Western" and "Eastern" pedagogical features are presented in contrast to each other (e.g., "abstract representation" vs. "concrete representation"). However, while our findings show that US and Chinese teachers' beliefs and noticing are characterized by certain "Western" and "Eastern" SPFs, the findings did not clearly confirm a dichotomous split across most of the dimensions. For instance, the Chinese teachers in this study continue to emphasize developing students' abstract thinking ("abstract representations") alongside working with concrete manipulatives ("concrete representation"). Unlike the American teachers, the Chinese teachers did not consider teacher-directed practices, such as whole group teaching sessions, to be in tension with the student-centered teaching. In fact, these Chinese teachers stressed the importance of teacher guidance and whole-class teaching demonstrations in facilitating student inquiry and exploration. Therefore, presenting

"Eastern" and "Western" pedagogical features as dichotomies may not be an accurate or effective representation of East Asian teachers' practices

Together, these indicate that the boundaries between "Eastern" and "Western" pedagogies are becoming increasingly blurred as East Asian teachers adopt more student-centered practice. At the same, time there are certain cultural characteristics that continue to be preserved and integrated within this broader shift towards student-centered pedagogy. Moving forward, cross-cultural research would benefit from a framework that presents these culturally distinctive features as complementary rather dichotomous practices.

Contributions to Practice

It is widely assumed that Western pedagogical practices are ideal for student-centered teaching whereas Eastern pedagogy is more compatible with teacher-directed instruction. We should therefore expect that Western educators would be more skilled at student-centered noticing than East Asian educators. Yet, this does not appear to be the case. Study after study has shown that East Asian teachers are more adept at noticing students' mathematical thinking, an essential aspect of student-centered instruction, compared to their Western counterparts (Damrau et al., 2022; Ding et al., 2022; Dreher et al., 2021; Miller & Zhou, 2007; Yang et al., 2019; 2021). On the other hand, Western teachers are more adept at noticing aspects that support a student-centered learning environment (Yang et al., 2019).

The findings from Paper Two suggests that identified specific Western and East Asian features that supported teachers' noticing of different instructional aspects: For example, stereotypical Western features such as *child-centeredness, general pedagogical knowledge,* and *generous praise* tend to support teachers' noticing of the classroom environment. East Asian

features such as *product-orientation*, *abstract representation*, and *whole class* teaching tend to support teachers' noticing of students' mathematical thinking.

Incorporating these pedagogical features can be set as a feasible goal for teachers' professional development. Determining that a teacher's practice seems to be rooted in primarily "Western" or "Eastern" pedagogy opens the way to designing professional development tasks for him or her that are likely to foster development of a more balanced approach to student-centered teaching. Several researchers have proposed useful frameworks that can foster such a transition (Luitel & Taylor, 2008; Savva, 2019; Smith & Hu, 2013).

Concluding Remarks

Prior research suggests that there are characteristics of teaching and learning that can be ascribed to Western cultures and some characteristics that are ascribed to Eastern cultures (Bryan et al., 2007). To investigate this, I assessed and compared the level of match between U.S. and Chinese teachers' pedagogical beliefs (both personal and cultural) to these stereotypically "Western" and "Eastern" features. The U.S. teachers exhibited higher levels of agreement with "Western" features in their personal pedagogical beliefs (T-PB) while the Chinese teachers' perceived cultural pedagogical beliefs (TP-CPB) were more closely aligned with "Eastern" features. Next, I investigated the level of match between U.S. and Chinese teachers' noticing patterns to these cultural stereotypes. For both groups, teachers' noticing patterns conformed more to "Western" and "Eastern" stereotypes than their beliefs. These findings indicate that important distinctions between Western and Eastern cultures of teaching and learning continue to influence teachers' beliefs and perceptions and that the influence of culture should be assessed, rather than inferred, in future cross-cultural research.

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