Testing the Relationship Between Teachers' Epistemological Beliefs (EB) and a Faculty's School Growth Mindset: Inter-cultural Comparison of EB Between East and West

Janet L. Hanson
Azusa Pacific University

This study compared elementary and middle school educators' (n=243) epistemological beliefs (EB) between western (southwestern US) and eastern (Asian) contexts. Results suggested contextual and cultural elements influence the development of teachers' individual EB factors of Certainty Knowledge and Learning/Effort Process. Innate/Fixed Ability and Criticizing Authority factors remained stable between cultures. EB dimensions showed stability across demographic characteristics of gender, total years teaching, position, and education level. Teachers' self-reports of their Innate/Fixed Ability showed a correlation (r = .23) with their perceptions of their school's growth mindset. A broad review of the literature and implications are provided.

Keywords: epistemology, pedagogy, development, teachers and administrators, growth mindset, eastern and western contexts, elementary and middle schools

INTRODUCTION

Research on teacher's epistemological beliefs (EBs) seeks insights into malleable factors that positively influence students' classroom behaviors and outcomes. Research to-date has provided mixed results in testing the factor structure of EBs using a variety of instruments, conceptualizations, and samples, resulting in multiple revisions across studies (Leal-Soto & Ferrer-Urbina, 2017). Though other research studies have hypothesized teachers' individual EBs are "composed of different, quite stable, semi-independent dimensions," this assumption needs further review (Maggioni & Parkinson, 2008, p. 447). Therefore, this current study tested the model structure of the 18–item *Epistemological Beliefs Questionnaire* (EBQ) in a western U.S. public school context with experienced teachers and administrators and compared the findings to a previous study (Lee, Zhang, & Song, 2013) using a sample of pre-service teachers in three cities in China. Evidence of contextual differences and similarities between participants' EBs collected in Western and Eastern cultural contexts is provided (Chan, 2004). Further, this current study extends the literature on the topic by comparing the data, grouped as independent dimensions, and overall EBQ results, with teachers' perceptions of their faculty's school growth mindset operationalized on the What's My School Mindset (WMSM) survey (Mindset Works, Inc., 2015). The EBQ instrument is purported to capture a teacher's beliefs about knowledge, learning, and his or her relationship to others in the learning process. The factors of a school's growth mindset are purported to operationalize teachers' perceptions of their faculty's belief they can help all students, in their school, grow and learn (Blackwell, 2012; Hanson, 2016).

A broad review of the literature is provided, which gleaned insights into the complex topic of teachers' individual EBs. Key considerations include the reasonableness of using Likert-style survey instruments to assess unconscious processes of educators, whether EBs ought to be viewed as traits or processes that can be "activated" (Hammer & Elby, 2002) or placed in an hierarchical order as developmental (e.g. scaled from naïve to sophisticated), whether the categories of epistemological resources (purported in the literature and used on the EBQ instrument of this current study) have practical significance, and how researchers conceptualize their approaches to the topic as integrated or compartmentalized, black and white, or connected in multiple ways of inclusiveness. These are just a few of the important elements to consider when seeking to understand the meaning of the data collected from the EBQ scale, its construct validity for use in a Western educational context, and factor reliabilities. Therefore, a triangulation with the literature and expert review were used to inform the conclusions drawn and to develop implications for practice from the results of this study.

Background of the Topic

EBs have been described as one's conceptions of the nature of knowledge, how knowledge is acquired, and ways of knowing. One's actions are belief driven and teachers' EBs have been shown to explain their conceptions about teaching and learning, thereby effecting their choices and behaviors in the classroom (Chan & Elliott, 2004). A key to student learning is self-regulation and teachers' EBs have been shown, through their teaching methods, to influence a student's process of evaluation, reflection, and choice of strategies to activate critical thinking (Hanson, 2016a & b; Maggioni & Parkinson, 2008). Burnette et al. (2013) explained "implicit theories are conceptually similar to ... [one's] worldview... [and] [r]egardless of achievement context or methodological approach, implicit theories are hypothesized to be related to an array of self-regulatory processes" (p. 658). Summers, Davis, and Hoy (2017) evaluated the effects of teacher EBs on students' beliefs and their perceptions of the classroom context. Their results indicated teachers' beliefs and expectations for a student's success correlated with their perceived relationship with the teacher, indirectly influencing the student's behaviors in the classroom. Further reading on this topic can be found in Hanson (2017a). Farrington et al. (2012) noted that "[w]hile numerous studies have identified specific aspects of the classroom context that contribute to strong academic mindsets, a gap persists between research findings and teachers' intentional use of strategies to promote positive student mindsets" (p. 37). This current study seeks to fill this gap in the literature by empirically testing an instrument for reliability in measuring teachers' EBs, using the instrument to collect data, and then connecting the results with other constructs. Empirically testing the reliability of an instrument useful to collect data on teachers' EBs in the context of the western U.S. would be useful to administrators and faculty who seek instruments for collecting data to evaluate their EBs. The results can be used to begin challenging dialogues on next steps in the process of continuous instructional improvement.

Research on implicit theories of mind, such as teachers' perceptions of their school's growth mindset culture and teachers' EBs are being reported in current literature, showing influences on teacher and student psychosocial factors contributing to improved school and student performance (Farrington et al., 2012). Thornton and McEntee (1995) described mindsets as a factor providing "insights into the social phenomenon of learning, the reciprocal exchange of ideas and information" that occurs in the school environment and are used to co-construct knowledge bases (p. 251). A school's context has been shown to strongly influence individuals' implicit theories and reciprocally to influence the school organization. How one perceives their world has also been linked to one's culture of origin (Hong, Benet-Martinez, Chiu, & Morris, 2003; Nisbett & Miyamoto, 2005). The construct validity and reliability of the WMSM survey used in this current study has been empirically tested in a variety of studies and contexts (Hanson, 2015; Hanson, Bangert & Ruff, 2016a &b).

Purpose

This current study sought to replicate the EBQ survey validation study performed using pre-service teachers in a Chinese setting in an effort to inform the reliability of the scale for use with teachers and

administrators in a western U.S. context. The proposed factors of a teacher's EBs included Innate/Fixed Ability, Learning Effort/Process, Criticizing Authority, and Certainty Knowledge (Lee et al., 2013). Factors of a school's growth mindset included Shared Leadership, Open Communication and Support, and Collaborative Planning (Hanson, 2016a). In sum, this study sought to empirically test the factor structure of the *Epistemological Beliefs Questionnaire* (EBQ), shown reliable with samples in an Asian context (Muis & Foy, 2010; Johnston, et al., 2000; Tsai, 2006) and to test the relationship with teachers' perceptions of their school's growth mindset. This current study used preexisting data from elementary and middle school teachers' and administrators in the western United States and seeks to fill the gap in the literature using a reliable instrument tested in a western US public school context. Methods included exploratory factor analysis (EFA), confirmatory factor analysis (CFA) (using polychoric correlations to account for the ordinal nature of Likert-style scale data), and distribution analyses of the data collected on the EBQ and WMSM Likert-type scales.

Overarching Questions

The overarching research questions driving the design of this study were:

Q1: What is the factor structure of the construct of teacher's epistemological beliefs as operationalized on the Epistemological Beliefs Questionnaire (EBQ) used in this study?

Q2: Do the factors and overall EBQ construct on the questionnaire demonstrate acceptable scale reliabilities, according to predetermined indices, for use in the context of U.S. public elementary and secondary schools in this study?

Q3: Are there any significant differences in epistemological beliefs with respect to gender, education level, total years teaching, and position?

Q4: Is there a relationship between the distribution of items in the factors of the EBQ, identified from the current study's EFA and CFA analyses, and teachers' and administrators' perceptions of their faculty's school growth mindset?

Definitions

Personal Epistemological Beliefs/Models (Hofer & Pintrich, 1997) refer to beliefs about "the ways that people acquire, justify, and use knowledge" (Greene, Cartiff, & Duke, 2018, p. 1084).

Epistemic Cognition is a "... cognitive process [that] refers to something that people *do* when they are prompted to reflect on the nature of what they regard as knowledge" "... thinking in action" (Maggioni & Parkinson, 2008, p. 447).

School Growth Mindset construct operationalizes a culture with a "common vision, sharing knowledge, support, and resources" (Blackwell, 2012, para. 6-10). A school growth mindset is a unidimensional construct with three sub factors: collaborative planning, shared leadership, and open communication & support (Hanson, Bangert, & Ruff, 2016).

Collaborative Planning is a factor of a school's growth mindset construct operationalized on the WMSM survey and describes "formal structures within the system providing opportunities for teachers and administrators to collaborate through observation, shared planning, and feedback to improve instruction" (Hanson, Bangert & Ruff, 2016, p. 250).

Open Communication and Support is a factor of a school's growth mindset construct operationalized on the WMSM survey and describes "teachers and administrators' informal activities to support student instruction and individual goals" (p. 250).

Shared Leadership is a factor of a school's growth mindset construct operationalized on the WMSM survey and describes "teacher and administrator engagement in collaborative decision-making processes" (p. 250).

The following sections of this paper provide a review of relevant literature on the varied conceptualizations of individual epistemological beliefs, researchers' conceptualizations, measures used to collect data on EB, and the findings relevant to student outcomes. A concept map (shown in Figure 1) was developed to organize the many and varied elements from the literature on the topic. A discussion of the instrument and factors selected for use in this replications study, comparison of the two samples' self-reports, and brief description of the Asian versus Western educational context are also provided. A section on the method, results, discussion and conclusion, implications for practice, and recommendations for future research also follow.

LITERATURE REVIEW

A review of the literature on the topic of teacher individual EBs revealed varied definitions and conceptualizations for similar constructs, with much overlap, contributing to one of the major problems for generalizing results of the broad range of studies. Louca, et al (2004) proposed an activation theory of individual EBs, suggesting individuals "have a range of cognitive resources for understanding knowledge" and that these resources become activated by students based upon the need presented in domain specific contexts (p. 58). Hammer and Elby (2013) described EB resources as "creation, manipulation, or application of knowledge" (p. 7). The literature also provided examples of a general and domain specific conceptualization of EBs and supported the hypothesis that epistemic beliefs have a domain-specific component (Buehl & Alexander, 2001; Muis et al., 2006 in Maggioni & Parkinson, p. 449). EBs have been conceptualized as contrasts between transmission of knowledge vs construction of knowledge and various stances toward knowledge such as acceptance, puzzlement, or doubt. The literature also showed parallel research on the topic of teachers' EBs was kept separated by differences in terminology and domains of the data bases.

The different conceptualizations of EBs required different research methods to test them. EB studies relied heavily on the use of quantitative survey research to find relationships between domain specific EBs and teaching practices. In contrast, a cognition and EB resources conceptualization tended to use qualitative interview protocols to collect rich descriptions of the participants' perceptions of the topic. Maggioni and Parkinson (2008) suggested this diversity could potentially contribute "a richer and more nuanced understanding of the relation between teachers' individual epistemology and instruction" and provide insight for teachers into understanding "how students become masters of their own learning processes" within the context of their classroom (Zimmerman, 2008, p. 167 in Maggioni & Parkinson, p. 447; Lee et al., 2013). Researchers also varied their focus based upon the discipline of the EB study. For example, science considered conceptualizations based on logical positivism and empiricism, while history considered construction of meaning versus knowledge as a collection of facts.

Dimensions Approach

Hammer and Elby (2013) suggested a "tacit presumption of unitarity" exists with survey researchers, where EB theories were viewed as fixed traits that manifest in one's behavior and preferences for specific conceptualizations of teaching (p. 13). Schommer (2008) developed an instrument based on this unitarity operationalization of EB as dichotomous constructs from a naïve to a sophisticated conceptualization. Schommer's (2008) dimensions approach to conceptualize teachers' self-reports of their EBs on a Likert-scale measure placed the constructs on a continuum ranging from a "naive view," at the lower end of the scale, to a "sophisticated view," at the higher end. The assumption was EBs are developmental, with the naïve worldview a less desirable belief in that it correlates with a traditional conceptualization of teaching and learning. Table 1 shows descriptions of the dimensions on the EBQ scale used by Lee et al. (2013), ranging from the low-end naïve constructs to the high-end sophisticated views.

TABLE 1
DESCRIPTIONS OF FACTORS ON THE EBQ SCALE USED IN THIS CURRENT STUDY, FROM NAÏVE (DUALISTIC) TO SOPHISTICATED (RELATIVISITIC) BELIEFS

	Naïve view - dualistic	Sophisticated view - relativistic
Innate fixed abilities	One's mental abilities are inborn and fixed at birth	One's mental abilities can change and grow with effort
Learning effort/process	Learning comes through drilling and mastery of skills	Individual knowledge is self-constructed and can be improved through effort
Criticizing authority	Authorities/experts can find the truth and transfer it to others	Learning occurs through one's personal experiences and reflection; authorities can be questioned and criticized
Certainty knowledge	Knowledge is fixed and certain	Knowledge is constantly evolving and changing

The literature reports the domains of EB factors fall into several categories. Debates rage over whether the items and their operationalizations correctly represent epistemological constructs. A variety of groupings have been proposed for factors of EBs including beliefs about learning, one's relationship to authority, and beliefs about the structure and control of knowledge. Researchers also argue that not all conceptualizations of constructs under these categories can truly be considered "epistemic" beliefs (Leal-Soto & Rodrigo Ferrer-Urbina, 2017).

Beliefs about knowledge sources refer to the structure and justification for ways of knowing one's beliefs (connected versus separate), beliefs about learning (speed and ability) (Schommer-Aikens, 2004), and one's attitudes, or dispositions, in their relationships with others in the process of developing knowledge (Leal-Soto & Ferrer-Urbina, 2017). These categories are further condensed into two categories; *epistemic* beliefs (beliefs *about knowledge* and ways of knowing) and *related* beliefs (beliefs *about learning* and one's relationships with others). A deep review of the literature and a comparison of the individual items making up the proposed constructs (factors) is warranted, when attempting to determine the construct validity of the factors, in order to recommend the usefulness of the overall EBQ scale and its reliability to capture participants' actual underlying implicit theories /worldviews about knowledge. Elby (2009) explained "If people's views about *the nature of knowing* and knowledge turn out to be separable from (despite being intertwined with) their views about *the nature of learning*, then it makes sense to define two separate areas of study corresponding to those two separable sets of psychological constructs" (p. 3).

Limitations of EBQ Research

Some researchers in the literature reported limitations of the dimensions approach. For example, a teacher might hold epistemological beliefs on both sides of the "traits" dimensions. Researchers may hold an assumption there is consistency across diverse contexts of learning, in which the beliefs are supposed to apply. Hammer and Elby (2002) reported the dimensions approach was "neither evident, nor, when made explicit, plausible" (p. 2). Sheehy, Budiyanto, Kaye, and Rofiah (2017) wrote that a dichotomous approach lacks sufficient dimension to operationalize the complexity of the broad range of learning conceptualizations. Conceptualizing EBs in theory as "cognitive structures" may be evaluated as neither correct nor incorrect. Box (1976) explained, "Since all models are wrong the scientist cannot obtain a 'correct' one by excessive elaboration." Some models are just more useful than others (p. 792). The "unitary ontology" view of EBs as a fixed traits presents a danger that might result in preparation programs seeking to "disassemble" what teachers currently believe and replace it with "correct" beliefs. For example, the context of schools might place constraints on teachers through requiring fidelity to mandated curriculum, school and district directives, and program requirements.
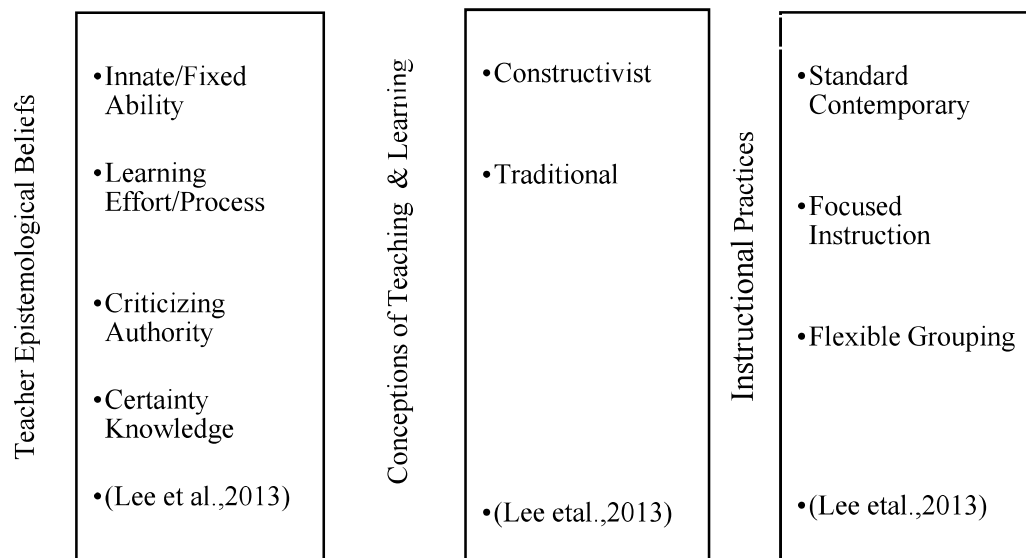
Other constraints on teachers might result from the varied levels of control they have over student engagement, or lack thereof, in the classroom. However, when EBs are viewed as resources that are activated in context, teachers could be supported with training and resources to improve the classroom context by encouraging student participation, to share their perspectives, promote flexible activation of students' EB resources, create cooperative groups, and provide constructivist activities. Teachers and administrators can provide strategies for students to go deeper into a topic of study (Hammer & Elby, 2013, p. 9 & 13).

Teachers' backgrounds and upbringing were considered to also influence their choice of teaching practices, apart from their reported worldviews. Novice teachers were shown to revert to traditional beliefs in spite of interventions to change teachers EBs and practices (Maggioni & Parkinson, 2008). Hofer (2008) in Lee et al. (2013) recommended further comparative studies be conducted on teachers' EB studies between Western and Asian contexts to discover within-country explanations for differences by culture (p. 121). Prior studies have suggested, since one's cultural context influences one's beliefs, the operationalizations and way participants understand the dimensions of the EB instrument may present cultural biases. For example, in the Chinese context (Chan & Elliot, 2002, 2004) the dimension Criticizing Authority was extracted but not in U.S. undergraduate students (Schommer, 1990). The factor Learning/Effort Process also differed in the Chinese context from results of the study performed with Schommer's U.S. sample.

Conceptions of Teaching and Learning

In Lee et al. (2013), a teacher's EBs were shown to influence the teachers' choice of classroom teaching practices through a direct relationship of their conceptions of teaching and learning, and indirectly mediating the influence of teachers' EBs on their instructional practices used in the classroom. Two categories of conceptions of teaching and learning will be discussed here and were identified from a distillation of the literature, constructivist and traditional. Theoretically, if a teachers' EBs are on the sophisticated end of the spectrum, this has been shown to predict a constructivist conception of teaching and learning, which may be compared to Novak's (2002) hierarchical nature of learning. Novak explained learning requires the individual to "actively seek to integrate new knowledge with knowledge already in [one's] cognitive structure" (p. 548). Figure 1 provides a model of the path of influence of teachers' EBs on their conceptions of teaching and learning and choices of strategies in the classroom.

FIGURE 1
DIMENSIONS OF EBQ, RELATED CONCEPTIONS OF TEACHING AND LEARNING AND INSTRUCTIONAL PRACTICES

Teacher Epistemological Beliefs
- Innate/Fixed Ability
- Learning Effort/Process
- Criticizing Authority
- Certainty Knowledge
- (Lee et al.,2013)

Conceptions of Teaching & Learning
- Constructivist
- Traditional
- (Lee etal.,2013)

Instructional Practices
- Standard Contemporary
- Focused Instruction
- Flexible Grouping
- (Lee etal.,2013)

One's cultural context has been shown to play a significant role in explaining the varied influence on student outcomes where teachers' conceptions about teaching and learning diverge. The assumption that constructivist approaches always produce improved student learning over traditional approaches may be naïve. A study performed in China revealed "…a pedagogical culture that has been based on 'passive transmission' and 'rote drilling' approaches nevertheless produces students who outperform their counterparts in the Western [cultures]" (Zhao, Valcke, Desoete, Sang, & Zhu, 2014, p. 2). However, certain psychosocial variables such as academic mindset ("innate/fixed abilities" on the EB scale) have been reported as context independent for both adults and students (Hanson, 2017c). Ultimately the differences between constructivist and traditional approaches can be distilled down to the difference between "student-centered" versus "teacher-centered" models. A traditionalist, "teacher-center," model focuses on teacher control of the classroom and direct instruction of the learning process (transmitter-listener and target-target interactions). The constructivist conception of teaching views the classroom interaction as a "student-centered" model, with cooperative grouping, audience-player and guide-learner roles, flexibility in activities from students interacting with the material, organization of the classroom, and student involvement in creating classroom rules (Zhao et al., 2014, pp. 2-3). Importantly, results of mixed method research studies found there was a statistically significant and positive relationship between teachers' EBs measured on a quantitative Likert-style survey and their classroom practices (Mataka, Saderholm, & Hodge, 2019).

Students With Special Needs

Teachers' EBs are an important consideration for teacher professional development in the area of inclusive educational practices. The variation between teachers' EBs may prove to be a key to explaining teachers' preferred pedagogical practices in the area of full inclusion. Teachers have "different constructions of inclusion in different cultures" (Sheehy et al., 2017, p. 51). Indonesian teachers' EBs were more predictive of their perspectives towards inclusive education than the context of the school types in the sample including inclusive, special, and regular education. Teachers with social constructivist views, (i.e. belief that individuals develop meaning in a social context), were more likely to believe all children can learn and reported a willingness for using inclusive education and greater flexibility in working in teacher teams. Teachers with more directive approaches showed less flexibility in their roles when working in two teacher classrooms in inclusive settings (Sheehy et al., 2015).

Cultural Context

Eastern

Students in Eastern cultures are taught by their parents to be self-effacing and humble and not to challenge authority. Traditional Confucius Chinese culture socializes children to respect adults and not question a teachers' authority. Teachers, authority figures, experts, and the written word have high status in Eastern cultural contexts. This high regard is different in quality than how authority is viewed in the U.S. According to a Confucius Chinese teaching, teachers wait for the student to make an effort first before showing them the way; therefore reflecting a high regard the role of effort and the learning process in knowledge acquisition. Effort in the Chinese context includes active inquiry and reflection as well as mastering facts by memorization and repetitive practice. Chan (2004) recommended care should be given, however, to avoid too narrow a conceptualization of the Chinese people through the lens of Confucianism. For example, there is a saying, "When you completely trust the book it is better to have no book," (Yu, personal conversation, May, 22, 2020), suggesting a history consistent with the EB factor Criticizing Authority; though the meaning may highlight the importance of thinking thoroughly about a matter under study rather than criticizing authority.

New cultural and educational reforms are being introduced in China, influencing teachers to engage in constructive practices in the classroom (Lee, Zhang, & Song, 2013). Modern-day cultural crises in China may have eroded some of the traditional trust in authority, when teachers' prior learning experiences were traditional and didactic. Individuals have been shown to hold two contradicting conceptualizations of EB in different contexts. Maggioni and Parkinson (2008) reported novice teachers

tended to revert to traditional beliefs when placed in different contexts, while more experienced teachers held to more relativistic views. Ozturk and Yilmaz-Tuzun (2017) reported a study using a sample of preservice teachers in Turkey. Their results diverged from the EB factors of Schommers' (1990) Epistemological Questionnaire. A review of the loadings in the table showed a single factor emerged combining items from innate/fixed, learning effort, and speed of learning. The factors omniscient authority, certain knowledge, and quick learning did not load and the scale reliability indices were lower than the acceptable range.

Western

Western culture is historically rooted in Christian spiritual traditions, scientific rationalism, pragmatism, materialism as representing success, and, as new technologies advanced, logical analysis. The modern Western perspective is characterized by a focus in educational institutions and research on self-concepts such as self-efficacy, self-worth, emotional appeals, and a strong appeal to individualism and independence. This focus on the individual differs from the Eastern context where individuals are taught to minimize their individuality, work toward group cohesion, and respect authority over self-belief. Yu (2017) reported U.S. students reported higher self-efficacy, self-belief, and motivation than their Eastern counterparts on the 2015 PISA exam. However, the U.S. students performed at the lowest level compared to students in the study from Eastern cultural contexts. "While enhancing self-efficacy can improve performance initially, inflating one's self-efficacy could drag down one's actual performance" after a certain point (slide 15). Additionally, Mindset interventions are increasingly used in schools in the Western context, emphasizing the belief in the ability to grow and learn through one's own efforts (Dweck, 2012; Dai & Cromley, 2014; Walton, 2014).

METHOD

Design and Data Source

This study used correlation analysis, scale reliability tests, exploratory factor analysis (EFA), and goodness-of-fit indices from confirmatory factor analysis (CFA) to determine the reliability of the factor structure of the *Epistemological Belief Questionnaire* (EBQ) in a sample of elementary and middle school teachers and administrators in one district in the western U.S. Software programs used to perform the analysis included Factor 10.10.03 (Lorenzo-Seva & Ferranco, 2020, Lisrel 9.3 (Joreskog & Sorbom, 2017), and JMP Pro 15.0.0 (SAS Institute, Inc., 2019). Pre-existing data was extracted from a TK-8 District Local Accountability Control Plan (LCAP) school culture survey completed at a mid-size, suburban/rural school district in a large southwestern state in the United States during the 2015/2016 school year. District administrators provided the survey in a standardized format to all teachers, using paper and pencil delivery to collect self-reports on Likert-style surveys. Teachers returned responses in sealed envelopes, with surveys coded for confidentiality of the participants. The response rate was approximately 90%. Researchers used SPSS version 22 to enter the data into files for analysis.

Participants

The following summary statistics describe the participant sample used in this study: Of the 243 valid surveys returned, 83% of the respondents were female (*n*= 201), 17% were male (*n*= 42), and one did not answer; years of teaching by category included 33% ≤ 7 years; 42% between 8 and 20 years, 23% > 20 years, 3% did not answer; 30% held BA degrees as their highest level of education, 68% held MA degrees, 1% had doctoral degrees and 1% reported other or no answer; 94% were teachers, 4.5% were administrators, and 1.5% were certified support staff such as councilors and speech therapists; 12% of the respondents taught at the TK or preschool levels (*n*=30), 62% taught at the elementary level (*n*=151), and 26% were at the middle school level (*n*= 63). A Wilcoxon-Mann-Whitney (or rank sum) test, a non-parametric alternative to a t-test, was performed to determine if there was a significant difference between teachers and administrators' survey responses. The results of the analysis suggested no

statistically significant difference existed and the administrator responses were retained in the study and included in the analyses.

Instruments
Epistemological Beliefs Questionnaire (EBQ)

The EBQ used by Lee et al. (2013) was selected for use in this study because of the parsimony of the factors, its empirically demonstrated reliability to collect data that predicted teachers' conceptions of teaching and learning and instructional practices related to the constructivist and traditional conceptions, and for use as a framework to interpret the results of this study. A meta-analysis of EBs scales used across a variety of study designs reported effect sizes for Schommer's EBQ scale, suggesting movement from a naïve (low) to sophisticated (high) score would be associated with a change of .328 standard deviations of an academic achievement measure, showing a small to medium effect. Teacher data was collected using 18 questions of Schommer's modified EBQ (Lee et al., 2013), which measures the follow constructs, with their Cronbach alpha provided: innate/fixed ability (α =.93), learning effort/process (α =.79), criticizing authority (α =.81), and certainty knowledge (α =.81). The instrument was developed and adapted, based on the conceptualization of epistemological beliefs by Schommer (1998) and work by Chan and Elliot (2004). The instrument demonstrated evidence of reliability and validity. In addition, their Exploratory Factor Analysis (EFA) showed the factor loadings ranging from .93 for the construct of innate/fixed ability, .74 to .76 for the construct of learning effort/process, .66 to .84 for the construct of criticizing authority, and .70 to .81 for the construct of certainty knowledge. For the teacher survey data, survey items grouped as follows: innate/fixed ability (q1-8), learning effort/process (q9-11), criticizing authority (q12-14), and certainty knowledge (q15-18). Appendix A provides the items on the EBQ scale with reliability scores.

What's My School Mindset (WMSM)

This survey collected teachers' perceptions of their school's growth mindset culture operationalized on 20 questions of the *WMSM* survey (Mindset Works, Inc., 2015). The survey has been tested for reliability and validity for measuring the following constructs, collaborative planning (α =.89), shared leadership (α =.88), and open communication and support (α =.73). The full-scale internal consistency reliability was tested at (α =.92) (Hanson, Bangert, & Ruff, 2016a). The WMSM scale can be viewed on the Mindset Works, Inc. website.

Variables and Data Analysis

Composite research variables were teachers' self-report data collected using the EBQ operationalizing the constructs of belief in one's innate/fixed ability, usefulness of learning effort/process to improve student outcomes, criticizing authority, and the certainty of knowledge. The following interpretations of the scales as scored in these analyses are described by Lee et al. (2013). Based upon the review of the relevant literature, researchers have debated over the appropriate categorization and operationalizations of EBs. The following proposed variables tested on the EBQ in this current study fall into two categories: beliefs about knowledge (sources, structure, and justification for), and beliefs about learning (speed, effort, and ability).

Beliefs About Learning

Innate/ Fixed Ability (q1-9 reversed) can be represented on a scale where one's ability is inborn and fixed at one end (higher scaled score) and one's ability is not innate but changeable through effort, represented by lower scaled score. High score reflects a belief one's abilities are fixed at birth. Learning/Effort Process (q9-11) can be represented by the belief that knowledge acquisition requires effort and that learning processes are more important than acquired facts at one end (upper end) or that learning needs little effort and acquired facts are more important, scaled at the other (lower end). High score reflects a belief that the learning process takes effort.

Beliefs About Knowledge

Criticizing Authority/Expert Knowledge (q12-14) ranges from low to high, teachers' beliefs that the source of knowledge is handed down by experts and authority is not criticized at one end (lower end) to knowledge being derived from one's experience and judgment, and experts can be questioned at the other (higher end). A higher score reflects a greater likelihood a participant will challenge the testimony of an authority figure. Certainty Knowledge (q15-18 reversed) relates to the nature of knowledge. This dimension ranges from a belief that knowledge is certain, unambiguous, and unchanged (higher end) to a belief that knowledge is tentative and ever changing (lower end). A high score reflects a belief that knowledge is unchanging and teachers must pass on a body of fixed knowledge to their students (Chan & Elliott, 2002).

RESULTS

The exploratory factor analysis uses techniques that seek to group survey items that have shared amounts of variance. Therefore, predetermined indices for communality scores of $> .20$ was used to determine retention of an item (Child, 2006). Where items had lower communality scores, a suggestion would be to identify additional factors contributing to the construct (Costello and Osborne, 2005). Prior to conducting the EFA, testing for multicollinearity between the items was performed. Because the items were measured on a Likert-style scale, polychoric correlation analysis was performed separating elementary and middle school levels, as differences have been shown to exist in psychosocial variables by school level (Hanson, 2015, Hanson, 2017a & b). Items with bivariate correlations $> .80$ suggest multicollinearity between items and therefore the suggestion is to remove one of the items in the pair of highly correlated items (Field, 2013) based upon review of the items and subjective determination of their interpretation as to which provides the most value to the scale. Additionally, the indices of determinant of the matrix $>.00001$ was used as criterion for removing items until these indices are met. Streiner (1994) suggested that the total variance explained by the retained factors should total $> .50$. According to Stevens (2012), factor loading significance varies by sample size. For this study (n=242) predetermined significance levels were set at loadings larger than 0.298. Acceptable cross-loadings required a difference of $>.20$ between the values loading on each factor. The EFA was conducted in two parts: first the innate/fixed scale was evaluated for factor loadings to identify a model for testing with CFA. When this scale was confirmed as reliable it was then entered with the remaining items and another EFA and CFA was conducted on the EBQ scale. This approach was used since the Innate/Fixed construct is a standalone construct and warranted separate analysis, as well as because the high correlations of items on the scale created difficulties in loadings with the other sub factors.

An EFA of the factor structure of the individual mindset subscale was performed to determine the relationships and reliability of the items on the innate/fixed construct prior to performing an EFA on the overall EBQ scale. Factor Analysis software package v 10.10.2 was used to perform the EFA using polychoric correlations with bootstrap parallel analysis. Two hundred and forty-two usable responses from elementary and secondary level faculty (n=231) and administrators (n=11). The 95% confidence level was 95% with a 5.16 percent confidence interval for the population of teachers and administrators completing the EBQ instrument. Criteria by Guilford (1954) indicated that the 242 participants for this study are more than adequate for instrument development research. The ratio of participants to innate/fixed items is 30 to 1 for the overall EBQ scale the ratio is 13 to 1 both of which are considered adequate for analyzing the scale using factor analysis (Field, 2000).

Prior to performing the EFA, the data collected was examined to check for missing data and evaluate the assumptions of normality including; random selection of the participant sample, data measured on a continuous scale, normally distributed data e.g. skew and kurtosis within ±2, and independence of the variables. The purpose of these analyses is to identify issues with the data that might adversely impact the exploratory and confirmatory factor analysis (Jöreskog, 1999; Netemeyer, Bearden, & Sharma, 2003). Since the responses were collected using Likert-scale survey items the data did not meet the criteria for

EFA analysis, neither were the respondents selected randomly as all faculty and students in the sample were requested to participate by the district administration for the LCAP culture survey. Neither did the data distribution meet the criteria of normal distribution since a review of the data revealed several items with skew and kurtosis values not within the range of ±2. Therefore, polychoric correlations and parallel analysis using bootstrapping (n=500) were used in the analysis.

EFA Model EBQ Scale

Next, the data was then subjected to an exploratory factor analysis, the full model was entered into the Factor 10.10.2 program using polychoric correlations, weighted forcing four factors. Polychoric correlation is advised when the univariate distributions of ordinal items are asymmetric or with excess of kurtosis A review of the correlations table for each item was conducted with Principal Components Analysis as the method for component extraction and Direct Oblimin rotation to achieve component simplicity. Direct Oblimin is used when the constructs are considered to not highly correlate as is the case with the constructs in this scale. The correlations between items were calculated and reviewed for items > .80. Appendix B provides the EBQ scale standardized variance/covariance matrix (polychoric correlation) from the Polychoric algorithm: Bayes modal estimation (Choi, Kim, Chen, & Dannels, 2011) (n=500). The procedure for determining the number of components was Optimal implementation of Parallel Analysis (PA) (Timmerman, & Lorenzo-Seva, 2011).

A review of the retained items showed item 2 had a correlation > .80 and was removed from the analysis. Results for the Bartlett's Test of Sphericity (p<.001) was found to be significant indicating that the items, although correlated, were not correlated so highly as to produce an identity matrix preventing the analysis from successfully reducing the data into interpretable components. A review of the component correlation tables showed no items had correlation > .80 and, therefore, multicollinearity was not considered an issue. The Determinant of the matrix was >.001 (D=.004), Bartlett's test was significant, and the KMO test yield a value in the "mediocre" range (KMO=.713). The initial solution revealed item 17r had a communality < 0.2 and was removed from the analysis. A review of the rotated component matrix revealed a four dimensional construct with each having loadings of ≥ 0.30 on three or more items except items 9 and 10 loading together. Therefore, the EFA was run again forcing three factors. The results revealed, item 18r had a communality < .20 and had a loadings < .30 across all components and was removed. The process was repeated until all items showed communalities > .20 and factor loadings > .30 on a single component. Item 10 cross loaded and was removed. This eventually yielded a stable three factor solution with 12 items loading ≥ 0.30 on each. The KMO statistic of sampling adequacy for this solution was 0.715 (values close to 1.0 are preferred and >.50 are acceptable). BC Bootstrap 95% confidence interval of KMO = (0.698; 0.758). The correlation matrix determinant was >0.0001 (D=.012), Bartlett's statistic was significant (df = 66, p < .0001), GFI = .991. The three extracted components accounted for 68.95% of the total variance in the data. A review of the communalities revealed all retained items >.20. Table 2 provides the item loadings, means, and standard deviations from the EFA for the full EBQ scale data. Table 4 provides the Inter-factor correlation matrix showing low correlations and suggesting multicollinearity was not an issue.

TABLE 2
COMPONENT LOADINGS, MEANS, AND STANDARD DEVIATIONS FROM PCA MATRIX[a] USING POLYCHORIC CORRELATIONS

Items on the Scale	Component				
	Criticizing Authority	Learning/ Effort Process	Innate Fixed Ability	M	SD
12. Sometimes I do not believe the facts in textbooks written by authorities.	**.565**	-.019	-.012	3.44	1.21
13. Even advice from experts should often be questioned.	**.876**	.029	.067	4.28	1.08
14. I often wonder how much experts really know.	**.725**	-.051	-.086	3.74	1.20
9. How much you get from your learning depends mostly on your effort.	.137	**-.519**	-.087	4.78	1.04
11. If one tries hard enough, then one will understand the course material.	.063	**-.695**	-.038	4.12	1.14
15r. If scientists try hard enough, they can find the truth to almost anything.	-.146	**.532**	.066	3.62	1.16
16r. Anyone can figure out difficult concepts if one works hard enough.	.073	**.906**	-.062	3.17	1.21
1r. There is not much you can do to make yourself smarter as your ability is fixed at birth.	-.096	-.084	**.601**	5.52	.718
4r. Some people are born good learners, others are just stuck with limited abilities.	.029	.026	**.815**	4.96	1.10
5r. Some children are born incapable of learning well in certain subjects.	.006	-.115	**.761**	4.79	1.18
6r. The ability to learn is innate/inborn.	-.007	.041	**.696**	4.75	1.40
7r. Students who begin school with "average" ability remain "average" throughout school.	.038	.077	**.731**	5.28	.743
Percent of Variance	29.65	23.75	16.64		
Eigenvalue	2.78	2.05	1.39		
Reliability Score (Orion[b])	.824	.819	.864		

[a] Maximum number of iterations 1000. Convergence value .0000; Bootstrap CI = 95%; Bootstrap samples = 500

[b] Overall Reliability of fully-Informative prior Oblique N-EAP scores (Ferrando & Lorenzo-Seva, 2016).

Notes: Extraction Method: Optimal implementation of Parallel Analysis (PA) (Timmerman, & Lorenzo-Seva, 2011). Rotation Method: Direct Oblimin.

The EBQ structure solution identified by the exploratory analysis was the result of not allowing the EBQ components to correlate. The low magnitude of inter-correlations between the three components provided empirical evidence that multicollinearity was not an issue. Table 3 provides the Inter-component correlation matrix correlations.

TABLE 3
INTER-COMPONENT CORRELATION MATRIX

Component	Criticizing Authority	Learning/Process	Innate/Fixed
1	1.000		
2	-.089	1.000	
3	-.057	-.167	1.000

Scale Reliability

The sample drawn from public elementary and middle school in the U.S yielded a three component model and the names of the components were retained based upon a review of the items including Criticizing Authority, Learning/Effort Process, and Innate/Fixed Abilities. Results revealed Criticizing Authority dimension retained all three items (q12-14, Cronbach's α= .824; Orion=.832). Learning/Effort Process retained two of the original four items (q9 & 11) and two items from Certainty Knowledge were captured under this dimension (q15 &16; reversed; Cronbach's α= .819; Orion=.874). Innate/Fixed Ability retained five items on the scale (q1, 4-7 reversed; Cronbach's α= .864; Orion= .861) with two items removed (q2 & 3) due to high correlation and low factor loadings. The remaining two items of Certainty Knowledge (q17 & 18, reversed) cross-loaded with other factors. Items q17 cross loaded on factors Innate/Fixed and Criticizing Authority and q18 showed low factor loadings across all factors, which can be explained again by high similarity in the phrases in the items.

Goodness-of-Fit Results of CFA

Goodness-of-fit indices were calculated to determine how well the proposed three-dimensional model from the EFA fit the data and results were compared to Lee et al.'s (2013) four-factor model. The "closeness" of the fit to the population model was supported by the *RMSEA* = .048 (< .05), indicating the model was a "good fit" to the data. This was further supported by a BC Bootstrap 95% confidence interval = (0.0280; 0.0535), *CFI* of .93 (> .90). All items in the model showed R^2 values > .25, providing empirical evidence of their value in explaining the constructs. The sensitivity ratio (SR) can be interpreted as the number of different factor levels than can be differentiated on the basis of the factor score estimates. The expected percentage of true differences (EPTD) is the estimated percentage of differences between the observed factor score estimates that are in the same direction as the corresponding true differences. The quality and effectiveness of the extracted components was further evaluated using Ferrando & Lorenzo-Seva's (2018) recommendations of Factor Determinacy Index (FDI) values above .90, marginal reliabilities above .80, Sensitivity ratio (SR) above 2, and Expected percentage of true differences (EPTDs) above 90%. Table 4 provides additional Goodness-of-fit indices for the individual components extracted.

TABLE 4
QUALITY OF EFFECTIVENESS STATISTICS FOR THE EXTRACTED COMPONENTS

Criterion for Evaluation	Component		
	Criticizing Authority	Learning/ Effort Process	Innate Fixed Ability
Factor Determinacy Index (FDI)	0.912	0.935	0.928
ORION marginal reliability	0.832	0.874	0.861
Sensitivity ratio (SR)*	2.226	2.631	2.490
Expected percentage of true differences (EPTD)**	89.7%	91.3%	90.8%

Table 5 provides a comparison of the Goodness-of-fit indices from the results of a three-dimensional model of this current study in a Western context and Lee et al.'s (2013) four-factor model developed from a sample drawn in an Eastern context.

TABLE 5
COMPARISION OF GOODNESS-OF-FIT INDICES FOR THE EBQ PROPOSED MODEL IN THIS CURRENT STUDY WITH THOSE OF THE MODEL TESTED BY LEE ET AL. (2013)

Number of Components- Current study	χ^2	df	RMSEA	CI	NNFI	CFI	GFI	RFI
3 EBQ	1272.66	66	.048	0.0280; 0.0535	.969	.985	.991	-

Number of Factors- Lee et al. study	χ^2	df	RMSEA	CI	NNFI	CFI	IFI	RFI
4 EBQ	648.71	129	.087	-	.94	.95	.95	.92

Differences by Demographic Categories

To answer research question 3, non-parametric Wilcoxon/Kruskal-Wallis Tests (Rank Sums), at a significance level of 0.05, were performed on the data for the three factors identified from the CFA analyses across gender, education level, total years teaching, and position. In summary, the χ^2 values of the three dimensions showed not significant at 0.05 level, with the exception of a difference in Learning/Effort Process Male and Females scores (M=4.94 SE=.06; M=4.55 SE=.13 respectively) implying there was no significant statistical differences in epistemological beliefs of the sampled teachers, administrators, and certified support personnel with respects to their gender, education level, total years teaching, and position with the exception noted.

DISCUSSION

> *FA is not worth the time necessary to understand it and carry it out.*
> Hills, 1977 in Habing (2005)
> *Factor analysis should not be used in most practical situations.*
> Chatfield and Collins, 1980, pg. 89

The introductory quotes in this section suggest problems with the process of factor analysis, which have been discussed in the review of the literature in this study. However, the empirical tests provided from this analysis do provide guidance in the "art" of conceptualizing theoretical constructs for study and practical applications from data captured on study instruments (Johnson and Wichern, 2002, pg. 517). The human element remains essential in considering the results of the analysis and retaining the decision-making power in reasoning through the meaning of the results. Based upon the review of the literature, empirical evidence from the data analysis, and a review of the item wording, the three-factor model proposed in this study is considered a useful model for the population. A three-factor structure for teacher EBs in a Western context is consistent with Leal-Soto and Ferrer-Urbina's (2017) replication study using Schraw's (in Hofer & Pintrich, 2002) EBI, which followed Schommer-Aitken's (2002) five-factor EBs model.

This current study found both similarities and differences between the findings of the pre-service Asian teachers' EB responses tested in Lee et al.'s (2013) study. The participants in the Western context interpreted Innate/Fixed Abilities factor similarly to the results of Lee et al., Chan (2004) and Schommer (2002) studies. Consistent again with Lee's study the EFA and CFA of this current study extracted an intact dimension, Criticizing Authority, comparable to Omniscient Authority in Schommer's operationalization, though not extracted in Schommer's study with pre-service teachers. Whether the

Criticizing Authority factor can be considered a disposition related to the teacher's stance toward authority or whether it represents an underlying belief about authority as "the" source of knowledge" is difficult to determine without further research from interview and observations of the participating teachers.

Contrary to Lee's study, the results of testing the EBQ scale show the factor Learning Effort/Process retained two items (q9 & 11) and combined with two items from Certainty Knowledge (q15& 16, reversed). This may be understood by reviewing the operationalization of these items. The wording may not have been sufficiently distinct to distinctly operationalize two separate constructs. A review of the items in Certainty Knowledge included phrases such as q15 "...work hard enough...," and q16 "...if one works hard enough..." compare this with phrases in Learning/Effort Process, q9 "...depends mostly on your effort...,"q10 "...takes a lot of work...," and q11 "...If one tries hard enough..." (Lee et al., 2013, p. 128). The results of the analysis in this current study are consistent with Chan (2004), who extracted a merged, or complex factor, consisting of items that combined operationalizations of learning effort and learning process. This is also consistent with Ozturk and Yilmaz-Tuzun's (2017) study which extracted a combined factor using Schommer's (1990) scale, including items from Innate Ability and Quick Learning. This makes sense in light of the literature which describes these three operationalized constructs as beliefs about learning (speed, effort, and ability), as opposed to EBs beliefs about knowledge (certainty). Further, in light of the high profile of growth mindset theories and Bandura's (1997a&b, 1986, 2001) self-efficacy theories being taught in the school district from which the data was drawn, the similar terminologies in the operationalizations of these psychosocial constructs could result in the participants rating these items as the same construct. The next section provides a discussion comparing the results of the data from the participants' responses on the WMSM survey and those of the EBQ.

Comparison With WMSM Scale

A visual review of the distributions from the factors of the WMSM and the EBQ show the relationship of the individual participants' data responses to the various constructs. Note that when a participant's score was high on the WMSM scale, he or she also reported high on the factors of WMSM, e.g. Collaborative Planning, Shared Leadership, and Open Communication & Support, and on the EBQ factor Innate/Fixed Ability. A review of the correlations and fit statistics provided further evidence of relationship between EBQ factor Innate/Fixed Ability and the WMSM scale ($r=.24$, $p < .0001$), suggesting a small effect and that a meaningful relationship exists. Figure 2 provides the Scatterplot Matrix of WMSM, Innate/Fixed Ability, Learning/Effort Process, and Criticizing Authority with correlations, 95% density ellipses, fit lines, and horizontal bar graphs. Figure 3 provides the Linking and Brushing Histograms of the data distributions of the WMSM Scale and EBQ and their factors/components.

FIGURE 2
SCATTERPLOT MATRIX OF EBQ COMPONENTS AND WMSM FACTORS WITH HISTOGRAMS, PEARSON CORRLEATIONS, FIT LINES, AND DENSITY PLOTS (95% CI)
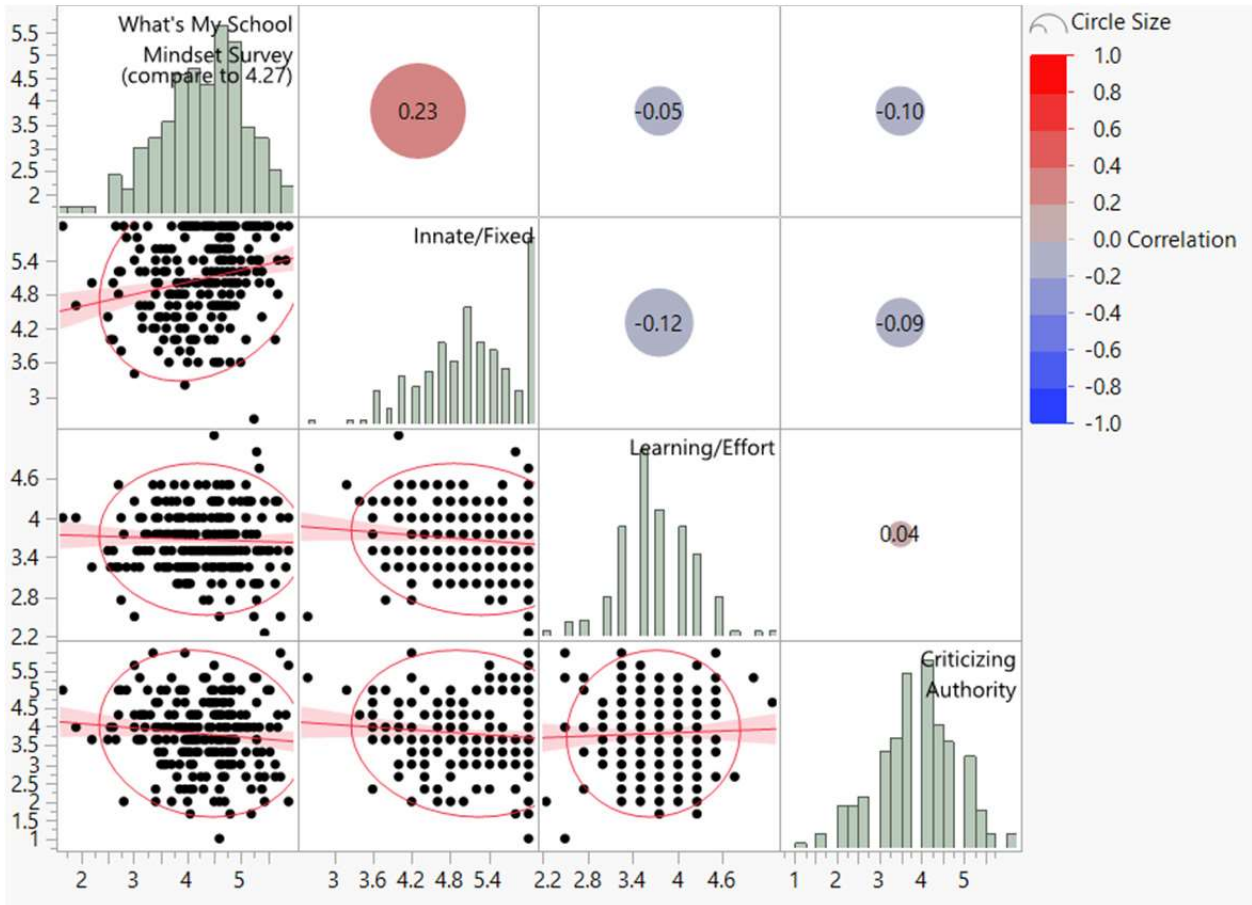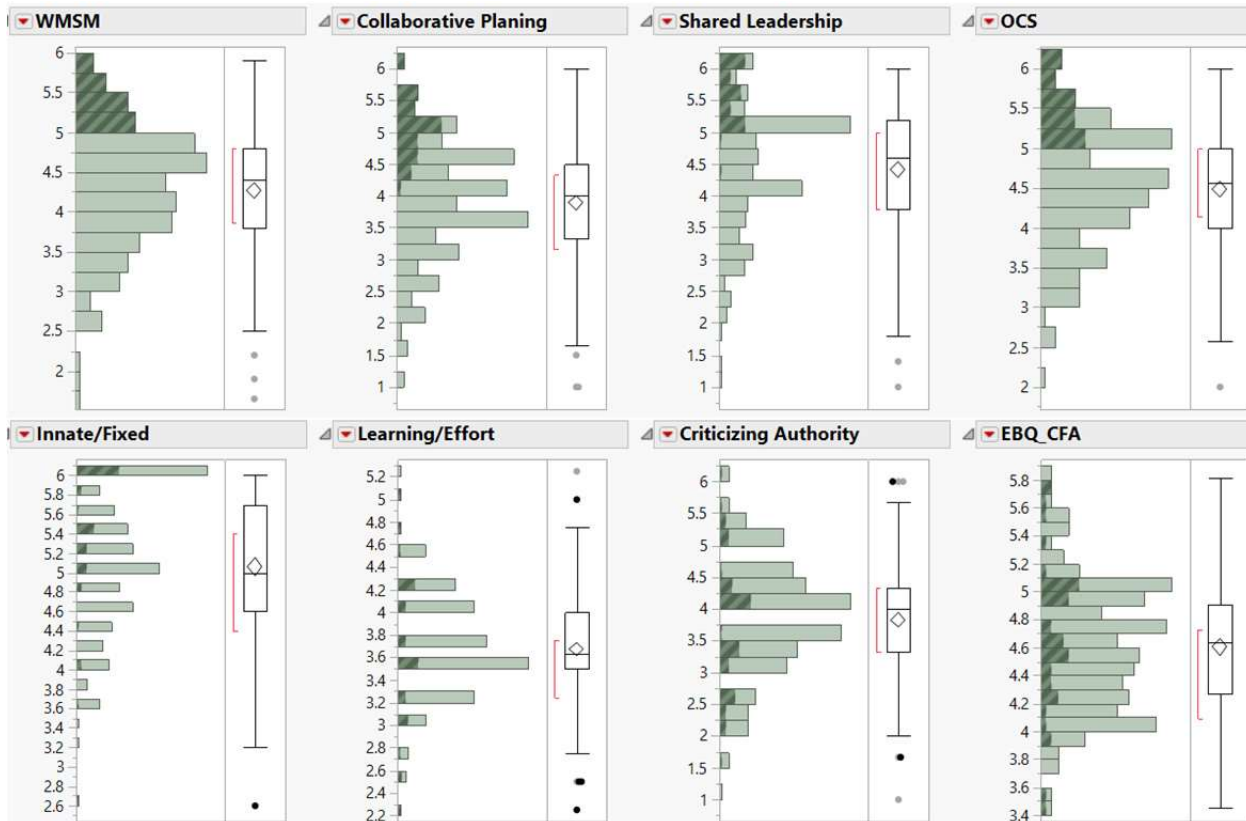
FIGURE 3
DATA DISTRIBUTION OF THE WMSM SCALE AND EBQ WITH THEIR
FACTORS/COMPONENTS: LINKING AND BRUSHING HISTORGRAMS

CONCLUSION

This current study contributed new empirical evidence to advance the literature in this underdeveloped area of epistemological beliefs measurement. The results of the EFA and Confirmatory Factor Analysis Goodness-of-fit statistics, for the factors proposed on the EBQ scale tested in this study, provided insights into experienced teacher and administrators' epistemic cognition, i.e. beliefs put into action or made explicit through the participants' ratings on the EBQ Likert-type survey. The results of this replication study suggest contextual and cultural elements influence the development of teachers' individual EB factors Certainty Knowledge and Learning/Effort Process, consistent with Schraw (2004), who found the overall factor structure of the EB construct was highly dependent on the sample tested. However, Innate/Fixed Ability and Criticizing Authority factors showed stability between Western and Eastern contexts, suggesting these items had valid operationalizations that were understood by participants consistently across diverse contexts. In addition, this study provided empirical evidence supporting some level of construct validity of the operationalized construct Innate/Fixed in relation to teachers' beliefs about their school growth mindset factors. Whether this construct relates theoretically to a teachers' epistemological beliefs or is distinguished as his or her beliefs about the fixedness or flexibility of one's ability to learn needs further testing.

The EBQ tested in this study may be considered practical for use in drawing reliable insights from the teachers, administrators, and certificated support staffs' self-reports of factors related to their EBs in the context of suburban elementary and middle schools in the western U.S., the context of this study. Importantly, the findings from this current study provided empirical evidence that individual mindset

construct and criticizing authority construct remained fairly stable between cultural contexts, while the constructs Learning/Effort Process and Certainty Knowledge showed distinct differences in that in Western contexts the two combined and in Eastern contexts the two showed separate construct reliability. Teachers' beliefs in the fixed or malleable aspect of one's abilities to learn (Innate/Fixed Abilities) and their beliefs about their relationship toward authority as the dispensers of knowledge showed evidence as reliable constructs.

This current study also provided empirical evidence of the general stability of the retained EB dimensions across demographic characteristics of gender, total years teaching, position, and education level. Finally, a comparison of the data distributions showed similarities between Innate/Fixed Ability, Criticizing Authority, and factors of the growth mindset construct. This finding adds to the literature showing the EBQ is capturing teachers' implicit theories of learning and dimensions of teachers' perceptions of their relationships with authority/experts and less reliable capturing purely epistemological constructs of beliefs about knowledge and ways of knowing e.g. Certainty Knowledge. It can be inferred that Elby's (2009) encouragement to question the validity of combining teachers' beliefs about learning with those about knowledge as a single EB conceptualization may be supported in the findings from this study.

Implications

Understanding teachers' EBs is a key in understanding teachers' conceptualizations about how students learn and how knowledge is developed, which may result in increased student well-being and growth (Hanson, 2017a; Hanson, 2017c). This section describes practical applications for schools using the results of this study.

Begin Dialogues Using Data From the EBQ

Teachers and administrators can use the validated EBQ, tested in this study, to collect data from their faculty. The results can be shared and become the foundation to challenging dialogues about teachers and administrators' beliefs related to knowledge, authority, and the learning processes in their school and classrooms. Exploring conceptualizations of teachers' individual EBs as a team has value when teachers can receive feedback. For example, administrators and teachers can discuss differences between the survey results (what they purport to "thinking about") and what they are actually "doing" in the classroom (epistemic cognition). Administrators and faculty can develop site specific strategies based-upon their teachers' current EB measurements, from the naïve vs sophisticated, moving them forward from where they are, rather than using pre-packaged curriculum and interventions that are widely disseminated as to-scale strategies.

Inclusive Classrooms

The results of this study can be applied practically by contextualizing applications for the classroom, including pre-service and professional development to prepare teachers to support students with special needs in inclusive educational settings. For example, a critical consideration is to provide trainings to build teachers' understanding of how their EBs influence one's flexibility to work in teams in inclusive classrooms. Promote administrators and teachers in reflecting on ways their EBs may be influencing their collective beliefs about their abilities to plan collaboratively, share leadership, and be supported by their administrator(s) and team members.

Professional Development

This could focus on developing teachers' understanding of constructivist teaching strategies useful to support the development of students' skills such as; self-monitoring, identification of appropriate strategies for the curriculum content, accept and implement feedback, and ways to meet the classroom learning goals. Useful teacher professional development is best when provided on-site, with just-in-time feedback, from a trusted other, focusing on increasing teachers' sophisticated beliefs about the source and

structure of knowledge and the learning process. More sophisticated views lead to increased resilience, creativity, and the desire to persist in the face of challenges (Hanson, 2017a & c).

Growth Mindset

In eastern countries parents teach their children to be humble and not stand out. In the US parents, teachers, and cultural values teach students to compete and believe they have the ability to do it. However, studies exploring self-efficacy and beliefs in one's own effort, in both Eastern and Western contexts, have shown a focus on this aspect of student motivation can be counterproductive under certain conditions. Since Western views of education are currently rooted in self-efficacy, with an increasing emphasis on growth mindset theory and developing pedagogies, teachers and administrators would benefit from developing a more balanced perspective, understanding how to provide a flexible approach between working independently and collaboratively to accomplish goals.

Recommendations

Future research could include testing teachers' EBs related to the hypothesized underlying construct "certainty of knowledge" to determine if this factor is a viable theoretical construct in the Western context, as distinct from the role of effort in the processes of learning. Further work is needed to develop an accurate operationalization for items to capture the underlying constructs and to test for reliability of the scale dimensions. Where items in this study showed lower communality scores, a suggestion would be to identify additional factors and new operationalizations of items contributing to the EB construct (Costello & Osborne, 2005).

REFERENCES

Bandura, A. (1977a). Self-efficacy: toward a unifying theory of behavioral change. *Psychology Review, 84*, 191–215. http://www.doi/10.1037/0033-295X.84.2.191

Bandura, A. (1997b). *Self-efficacy: the exercise of control.* New York, NY: W. H. Freeman and Company.

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory.* Englewood Cliffs: Prentice Hall.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*, 1-26. https://doi.org/10.1146/annurev.psych.52.1.1

Blackwell, L. (2012, March 28). *Developing a growth mindset school culture.* Retrieved December 20, 2014, from http://community.mindsetworks.com/developing-a-growth-mindset-school-culture

Box, G.E.P. (1976). Science and statistics. *Journal of the American Statistical Association, 71*(356), 791-799. Retrieved from http://links.jstor.org/sici?sici=0162-1459%28197612%2971%3A356%3C791%3ASAS%3E2.0.CO%3B2-W

Brown, T.A. (2015). *Confirmatory factor analysis for applied research* (2nd ed.). New York:

Buehl, M.M., & Alexander, A.A. (2001). Beliefs about academic knowledge. *Educational Psychology Review, 13*(4), 385–418. Retrieved from https://link.springer.com/article/10.1023/A:1011917914756

Burnette, J.L., O'Boyle, E.H., VanEpps, E.M., Pollack, J.M., & Finkel, E.J. (2013). Mind-sets matter: A meta-analytic review of implicit theories and self-regulation. *Psychological Bulletin, 139*(3), 655–701. https://www.doi.org/10.1037/a0029531

Chan, K. (2004). Preservice teachers' epistemological beliefs and conceptions about teaching and learning: Cultural implications for research in teacher education. *Australian Journal of Education, 29*(1), 1-13. http://dx.doi.org/10.14221/ajte.2004v29n1.1

Chan, K.W., & Elliot, R.G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education, 20*, 817-831. https://doi.org/10.1016/j.tate.2004.09.002

Chatfield, C., & Collins, A.J. (1980). *Introduction to Multivariate Analysis.* London: Chapman and Hall.

Child, D. (2006). *The essentials of factor analysis* (3rd ed.). New York, NY: Continuum International Publishing Group.

Choi, J., Kim, S., Chen, J., & Dannels, S. (2011). A comparison of maximum likelihood and Bayesian Estimation for polychoric correlation using Monte Carlo Simulation. *Journal of Educational and Behavioral Statistics, 36*(4), 523-549. https://doi.org/10.3102/1076998610381398

Costello, A.B., & Osborne, J.W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research & Evaluation, 10*(7), 1-9. Retrieved September 28, 2016, from http://pareonline.net/pdf/v10n7.pdf

Dai, T., & Cromley, J.G. (2014). Changes in implicit theories of ability in biology and dropout from STEM majors: A latent growth curve approach. *Contemporary Educational Psychology, 39(*3), 233-247. https://doi.org/10.1016/j.cedpsych.2014.06.003

Dweck, C.S. (2002). Beliefs that make smart people dumb. In R. J. Sternberg (Ed.), *Why smart people do stupid things*. New Haven, CT: Yale University Press.

Dweck, C.S. (2012). Mindsets and human nature: Promoting change in the Middle East, the schoolyard, the racial divide, and willpower. *American Psychologist, 67*(8), 614-622.

Elby, A. (2009). Defining Personal Epistemology: A Response to and. *The Journal of the Learning Sciences, 18*(1), 138-149. Retrieved May 31, 2020, from https://www.researchgate.net/profile/Andrew_Elby/publication/248942270_Defining_Personal_E pistemology_A_Response_to_Hofer_Pintrich_1997_and_Sandoval_2005/links/56f14a6208aec63 f4c9b546e/Defining-Personal-Epistemology-A-Response-to-Hofer-Pintrich-1997-and-Sandoval-2005.pdf

Farrington, C., Roderick, M., Allensworth, E., Nagaoka, J., Seneca-Keyes, T., Johnson, D., & Beechum, N. (2012, June 1). *Teaching adolescents to become learners, the role of noncognitive factors in shaping school performance: A critical literature review*. U Chicago Consortium on Chicago School Research. Retrieved December 8, 2014, from https://files.eric.ed.gov/fulltext/ED542543.pdf

Ferrando, P.J., & Lorenzo-Seva, U. (2016). A note on improving EAP trait estimation in oblique factor-analytic and item response theory models. *Psicologica, 37*, 235-247. Retrieved from https://www.uv.es/psicologica/articulos2.16/7Ferrando.pdf

Field, A. (2000). *Discovering statistics using SPSS for windows*. London-Thousand Oaks-New Delhi: Sage publications.

Field, A. (2009). *Discovering statistics using SPSS*. London: SAGE.

Field, A.P. (2013). *Discovering statistics using IBM SPSS statistics: and sex and drugs and rock 'n' roll* (4th ed.). Los Angeles: Sage.

Goddard, R.D., Hoy, W.K., & Woolfolk, A. (2000). Collective faculty efficacy: Its meaning, measure, and effect on student achievement. *American Education Research Journal, 37*(2), 479-507. http://dx.doi.org/10.3102/00028312037002479

Greene, J.A., Cartiff, B.M., & Duke, R.F. (2018). A meta-analytic review of the relationship between epistemic cognition and academic achievement. *Journal of Educational Psychology, 110*(8), 1084–1111. https://doi.org/10.1037/edu0000263
Guilford Press.

Guilford, J.P. (1954). *Psychometric methods* (2nd ed.). New York: McGraw-Hill.

Habing, B. (2005). *Exploratory factor analysis*. University of South Carolina. Retrieved May 31, 2020, from http://people.stat.sc.edu/habing/courses/530/EFA2005.pdf

Hammer, D. (1995). Epistemological considerations in teaching introductory physics. *Science Education, 79*(4), 393–413. http://www.doi.org/10.1002/sce.3730790404.

Hammer, D., & Elby, A. (2002). On the form of a personal epistemology. In B.K. Hofer & P.R. Pintrich, (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp 169-190). Mahwah, NJ: Erlbaum.

Hanson, J.L. (2017a). *Manage your mindset: Maximize your power of personal choice*. Lanham, MD: Rowman & Littlefield.

Hanson, J. (2017b). Testing the difference between school level and academic mindset in the classroom: Implications for developing student psycho-social skills in secondary school classrooms. *Journal of Educational Issues, 3*(1), 44-63. http://dx.doi.org/10.5296/jei.v3i1.10479

Hanson, J. (2017c). Determination and validation of the Project for Educational Research That Scales (PERTS) Survey factor structure. *Journal of Educational Issues, 3*(1), 64-82. Retrieved from https://eric.ed.gov/?id=EJ1131721

Hanson, J., Bangert, A., & Ruff, W. (2016a). A validation study of the What's My School Mindset? Survey. *Journal of Educational Issues, 2*(2), 244-266. http://dx.doi.org/10.5296/jei.v2i2.10138

Hanson, J., Bangert, A., & Ruff, W. (2016b). Investigating the relationship between school level and a school growth mindset. *Journal of Educational Issues, 2*(2), 203-221. http://www.macrothink.org/journal/index.php/jei/article/view/10052

Heo, H., Leppisaari, I., & Lee, O. (2018,). Exploring learning culture in Finnish and South Korean classrooms. *Journal of Educational Research, 111*(4), 459-472. Retrieved from https://eric.ed.gov/?id=EJ1182024

Hills, M. (1977). Book Review. *Applied Statistics, 26,* 339-340. Retrieved from http://people.stat.sc.edu/habing/courses/530EFA.pdf

Hofer, B., & Pintrich, P.R. (1997). The development of epistemological theories: Beliefs about knowledge, knowing, and their relation to learning. *Review of Educational Research, 67*(1), 88–140. https://doi.org/10.3102/00346543067001088

Hofer, B., & Pintrich, P.R. (Eds.). (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp 169-190). Mahwah, NJ: Erlbaum.

Hong, Y., Benet-Martínez, V., Chiu, C., & Morris, M. (2003). Boundaries of cultural influence: Construct activation as a mechanism for cultural differences in social perception. *Journal of Cross-Cultural Psychology, 34,* 453-464. https://doi.org/10.1177/0022022103034004005 http://www.icaseonline.net/journal/index.php/sei/article/view/157

Johnson, R.A., & Wichern, D.W. (2002). *Applied multivariate statistical analyses* (5th Ed). Upper Saddle River, NJ: Prentice Hall.

Johnston, P., Woodside-Jiron, H., Day, J., & National Research Center on English Learning and Achievement, A.N. (2000). *Teaching and Learning Literate Epistemologies.* CELA Research Report. Retrieved from https://eric.ed.gov/?id=ED444184

Jöreskog, K.G. (1999). *How large can a standardized coefficient be.* Unpublished Technical Report. Retrieved June 5, 2015, from http://www.ssicentral.com/lisrel/techdocs/HowLargeCanaStandardizedCoefficientbe.pdf

Jöreskog, K.G., & Sörbom, D. (2015). *LISREL* (version 9.2) [Computer Software]. Chicago: Scientific Software, Inc.

Leal-Soto, F., & Ferrer-Urbina, R. (2017). Three-factor structure for Epistemic Belief Inventory: A cross-validation study. *PLoS ONE, 12*(3), e0173295. http://www.doi.org/10.1371/journal.pone.0173295

Lee, J., Zhang, Z., & Song, H. (2013). Effects of epistemological and pedagogical beliefs on the instructional practices of teachers: A Chinese perspective. *Australian Journal of Teacher Education, 38*(12), 119–146. Retrieved January 18, 2015, from http://ro.ecu.edu.au/ajte/vol38/iss12/8/

Lorenzo-Seva, U., & Ferrando, P. J. (2020). *Factor Analysis 10.10.03.* Rovira i Virgili University, Tarragona, Spain. Retrieved from http://psico.fcep.urv.es/utilitats/factor/Download.html

Maggioni, L., & Parkinson, M. (2008). The role of teacher epistemic cognition, epistemic beliefs, and calibration in instruction. *Educational Psychology Review, 20*(4), 445-461. https://doi.org/10.1007/s10648-008-9081-8

Mataka, L.M., Saderholm, J.C., & Hodge, T. (2019). Faculty epistemological beliefs and the influence of professional development. *Science Education International, 30*(4), 364–372. Retrieved from

Mindset Works, Inc. (2015). *What's My School Mindset?* (para. 5). Retrieved May 31, 2020, from https://blog.mindsetworks.com/what-s-my-school-mindset

Muis, K.R., & Foy, M.J. (2010). The effects of teachers' beliefs on elementary students' beliefs, motivation, and achievement in mathematics. In L.D. Bendixen & F.C. Feucht (Eds.), *Personal epistemology in the classroom: Theory, research, and implications for practice* (pp. 409–434). Cambridge, UK: Cambridge University Press.

Netemeyer, R.G., Bearden, W.O., & Sharma, S. (2003). *Scaling procedures: Issues and applications.* Thousand Oaks: Sage Publications. http://dx.doi.org/10.4135/9781412985772

Nisbett, R., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. *Trends in Cognitive Sciences, 9*(10), 467-473. http://dx.doi.org/10.1016/j.tics.2005. 08.004

Novak, J.D. (2002). Meaningful learning: The essential factor for conceptual change in limited or appropriate propositional hierarchies (LIPHs) leading to empowerment of learners. *Science Education, 86*(4), 548-571. https://doi.org/10.1002/sce.10032

Ozturk, N., & Yilmaz-Tuzun, O. (2017). Preservice science teachers' epistemological beliefs and informal reasoning regarding socioscientific issues. *Research in Science Education, 47*(6), 1275–1304. Retrieved from https://rd.springer.com/article/10.1007/s11165-016-9548-4

SAS, Institute. (2019). *JMP Pro 15.0.0 (390308).* Statistical discovery from SAS. Retrieved from https://www.jmp.com

Schommer, M. (1990). The effects of beliefs about the nature of knowledge in comprehension. *Journal of Educational Psychology, 82*(3), 498 - 504. https://doi.org/10.1037/0022-0663.82.3.498

Schommer, M. (1998). The influence of age and education on epistemological beliefs. *British Journal of Educational Psychology, 68*, 551-562. http://www.doi.org/10.1111/j.2044-8279.1998.tb01311.x

Schommer-Aikins, M. (2004). Explaining the epistemological belief system: Introducing the embedded systemic model and coordinated research approach. *Educational Psychologist, 39*(1), 19-29. https://doi.org/10.1207/s15326985ep3901_3

Schraw, G. (2013). Conceptual integration and measurement of epistemological and ontological beliefs in educational research. *ISRN Education*, pp. 1-19. https://doi.org/10.1155/2013/327680

Sheehy, K., Budiyanto, Kaye, H., & Rofiah, K. (2019). Indonesian teachers' epistemological beliefs and inclusive education. *Journal of Intellectual Disabilities, 23*(1), 39-56. https://doi.org/10.1177/1744629517717613

Sheehy, Kieron, & Budiyanto. (2015). The pedagogic beliefs of Indonesian teachers in inclusive schools. *International Journal of Disability, Development and Education, 62*(5), 469–485. https://doi.org/10.1080/1034912X.2015.1061109

Streiner, D.L. (1994). Figuring out factors: The use and misuse of factor analysis. *The Canadian Journal of Psychiatry, 39*, 135-140. https://doi.org/10.1177/070674379403900303

Summers, J.J., Davis, H.A., & Hoy, A.W. (2017). The effects of teachers' efficacy beliefs on students' perceptions of teacher relationship quality. *Learning and Individual Differences, 53*, 17-25. https://doi.org/10.1016/j.lindif.2016.10.004

Thornton, L.J., II, & McEntee, M.E. (1995). Learner centered schools as a mindset, and the connection with mindfulness and multiculturalism. *Theory into Practice, 34*(4), 250-57. https://doi.org/10.1080/00405849509543688

Timmerman, M.E., & Lorenzo-Seva, U. (2011). Dimensionality assessment of ordered polytomous items with parallel analysis. *Psychological Methods, 16*, 209-220. http://www.doi.org/10.1037/a0023353

Tsai, C.C. (2002). Nested epistemologies: science teachers' beliefs of teaching, learning and science. *International Journal of Science Education, 24*(8), 771-783. https://doi.org/10.1080/09500690110049132

Walton, G.M. (2014). The new science of wise psychological interventions. *Current Directions in Psychological Science, 23*(1), 73-82. http://dx.doi.org/10.1177/0963721413512856

Yu, C.H., Lee, H.S., Gan, S., & Brown, E. (2017, September). *Nonlinear modeling with big data in SAS and JMP.* Paper presented at Western Users of SAS Software Conference, Long Beach, CA. Retrieved from https://www.lexjansen.com/wuss/2017/34_Final_Paper_PDF.pdf

Zhao, N., Valcke, M., Desoete, A., Sang, G., & Zhu, C. (2014). Does teacher-centered teaching contribute to students' performance in primary school? A video analysis in Mainland China. *International Journal of Research Studies in Education*, *3*(3), 21-34. http://www.doi/ 10.5861/ijrse.2014.729 Retrieved January 25, 2020, from https://www.researchgate.net/publication/264974535_httpconsortiacademiaorgindexphpijrsearticleview729

<p style="text-align:center">APPENDIX A
EPISTEMOLOGICAL BELIEFS QUESTIONNAIRE (CHAN & ELLIOT, 2004)</p>

Survey Items by Number and Subscale Category	Factor loadings*
Innate/Fixed Ability	
1. There is not much you can do to make yourself smarter as your ability is fixed at birth.	0.82
2. Our abilities to learn are fixed at birth.	0.90
3. One's innate ability limits what one can do.	0.84
4. Some people are born good learners, others are just stuck with limited abilities.	0.73
5. Some children are born incapable of learning well in certain subjects.	0.71
6. The ability to learn is innate/inborn.	0.74
7. Students who begin school with "average" ability remain "average" throughout school.	0.73
8. The really smart students do not have to work hard to do well in school.	0.67
Learning Effort/Process	
9. How much you get from your learning depends mostly on your effort.	0.75
10. Getting ahead takes a lot of work.	0.76
11. If one tries hard enough, then one will understand the course material.	0.74
Criticizing Authority (originally named as Authority/Expert Knowledge)	
12. Sometimes I do not believe the facts in textbooks written by authorities.	0.82
13. Even advice from experts should often be questioned.	0.84
14. I often wonder how much experts really know.	0.66
Certainty Knowledge	
15. If scientists try hard enough, they can find the truth to almost anything.	0.70
16. Anyone can figure out difficult concepts if one works hard enough.	0.70
17. I believe there should exist a teaching method applicable to all learning situations.	0.81
18. Scientific knowledge is certain and does not change.	0.76

Note: *Lee, J., Zhang, Z., Song, H. (2013) Effects of epistemological and pedagogical beliefs on the instructional practices of teachers: a Chinese perspective. *Australian Journal of Teacher Education 38*(12): 119–146. Available at: http://ro.ecu.edu.au/ajte/vol38/iss12/8/

APPENDIX B
EBQ STANDARDIZED VARIANCE/COVARIANCE MATRIX
(POLYCHORIC CORRELATIONS)[a] (n=500)

Item	1	4	5	6	7	9	10	11	12	13	14	15	16	17	18
V 1	1.000														
V 4	0.519	1.000													
V 5	0.417	0.659	1.000												
V 6	0.409	0.580	0.544	1.000											
V 7	0.498	0.525	0.564	0.479	1.000										
V 9	0.052	-0.011	-0.004	-0.098	0.051	1.000									
V 10	-0.050	-0.056	-0.077	-0.087	0.032	0.536	1.000								
V 11	0.079	0.059	0.111	0.059	0.007	0.449	0.278	1.000							
V 12	-0.069	0.039	-0.061	-0.030	-0.047	0.102	0.240	0.152	1.000						
V 13	-0.052	-0.027	0.011	-0.027	0.125	0.193	0.320	0.046	0.495	1.000					
V 14	-0.158	-0.052	-0.036	-0.068	-0.138	0.118	0.128	0.119	0.422	0.628	1.000				
V 15	0.003	-0.011	-0.128	-0.031	0.105	-0.275	-0.129	-0.341	-0.072	-0.158	-0.220	1.000			
V 16	-0.235	-0.122	-0.300	-0.097	-0.083	-0.424	-0.124	-0.609	-0.006	-0.010	-0.022	0.508	1.000		
V 17	-0.170	0.090	-0.048	-0.044	-0.019	-0.058	-0.080	-0.073	-0.058	-0.003	0.076	0.148	0.192	1.000	
V 18	0.110	0.228	0.107	0.095	0.144	0.019	0.120	-0.153	0.049	0.098	0.065	0.248	0.117	0.299	1.000

Note: [a]Polychoric algorithm: Bayes modal estimation; Choi, Kim, Chen, & Dannels, 2011) (*n*=500)