Pre-service Mathematics Teachers' Epistemological Beliefs and Instructional Practices in Northwest China

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ABSTRACT

This study investigates the relationship between pre-service mathematics teachers' epistemological beliefs and reform-oriented instructional practices in Northwest China. A total of 635 participants from normal universities and teacher colleges completed validated questionnaires measuring their beliefs about the nature of mathematics (traditionalist vs. constructivist), beliefs about mathematics learning and teaching (teacher-direction vs. student-active-learning), and instructional practices (cognitive activation and personal learning support). Descriptive statistics, correlation analyses, and multiple regression analyses were conducted. The results revealed that both constructivist and student-active-learning beliefs significantly predicted reform-oriented instructional practices, including cognitive activation and personal learning support. Traditionalist and teacher-direction beliefs showed limited or no predictive effects. These findings highlight that pre-service teachers' constructivist epistemological beliefs are positively associated with reform-oriented instruction approaches, while their traditional beliefs may coexist without strong behavioral influence. The study extends the understanding of belief–practice relationships in underrepresented Chinese regions and provides implications for teacher education programs seeking to foster reflective and reform-oriented instructional practices.

Keywords: Epistemological beliefs; Mathematics teaching and learning; Pre-service teachers; Instructional practices; Cognitive activation; Personal learning support; Northwest China

INTRODUCTION

Mathematics education was long recognized as a critical foundation for the development of problem solving, logical thinking and scientific literacy. International assessments, including the Programme for International Student Assessment (PISA) underscore the critical role of mathematical achievement for national competitiveness and personal career success(Schleicher, 2019). However, even though students' mathematical achievement is being widely seen as the pillar of their educational and eventual career prospects, students' achievement outcomes, which have gained emphasis in mathematics education, still confront an underlying challenge from teachers' epistemological beliefs, which may influence teachers' instructional practices. These systemized beliefs on mathematics, concerning the nature of mathematics as well as its' learning and teaching have now become widely accepted as important drivers for teachers' instructional choices of strategies and behaviors in classroom and consequently, ultimately, student learning (Beswick, 2012; Philipp, 2007).

Epistemological beliefs refer to individuals' personal beliefs about the nature of knowledge, its process of acquisition, and the factors influencing one's understanding and interpretation of knowledge(Hofer & Pintrich, 1997; Mahasneh, 2018; Ongowo, 2020). These beliefs are given particular importance in preparation for pre-service teachers, as they are young adults whose beliefs remain malleable despite later teaching practice, but will later steer their activities in the classroom. In mathematics education, three domains of epistemological beliefs are frequently salient: (a) beliefs about the nature of mathematics (fixed body of truths and rules vs. human's construction and creation), (b)beliefs about learning and teaching mathematics (memorization vs. conceptual understanding or teacher transmission vs. student focused facilitation), and these guide the teachers' actions at instructional reasoning, consciously or unconsciously, and inform a teacher's interpretations of educational reforms and classroom reality(Pajares, 1992; Schoenfeld, 2016).

Empirical research has consistently identified relationships between teachers' epistemological beliefs and their instructional decisions and strategies. For instance, traditionalists with absolutist views of mathematics tend to favor procedural teaching and direct instruction(Perry et al., 2002, 2006) and constructivists more likely to emphasize strategies such as cognitive activation, problem solving, inquiry etc (Beswick, 2012). In addition, teachers who understand mathematics as a codified set of procedures and regulations are more likely to adopt teacher-directed practices of rote learning and memorization. By contrast, teachers who view mathematics as a discipline of changing inquiry, are instead more liable to encourage student-active-learning practices of reasoning, problem solving and inquiry-based learning(Ernest, 1989; Schoenfeld, 2016). These ideological orientations are not just matters of philosophical agreement but have real influences on educational practices, including cognitive activation and support for personalized learning, which both correlate with enhanced student engagement and achievement(Kunter et al., 2013). In pre-service settings, beliefs are highly fluid inviting the teacher education programs for powerful sites for transformation(Richardson, 1996). However, other findings have indicated that cultural norms and even personal learning experiences may limit how far our epistemological change can be translated into classroom practice (Cross, 2009; Lerman, 1990).

Although international scholarship has shed light on the correlations between epistemological beliefs and instructional practices and has achieved important research progress, several gaps still remain. Firstly, when most existing studies have been conducted in Western contexts or in well-developed large urban center of Asia, less is known about how pre-service teachers in less-developed inner-land regions such as Northwest China conceptualize mathematics and how their epistemological beliefs influence intended practices. Furthermore, even in the the context of well-developed Asia area such as East China, prior studies tend to prioritize the importance of teachers' mathematical content knowledge rather than affective or epistemological orientations into account (Leung et al., 2015; Li et al., 2024). Consequently, the role of beliefs in shaping pre-service teachers' instructional practices remains underexplored. As one of less economically developed inner-land province, Gansu faces challenges including limited educational resources, high proportions of ethnic minority students, and strong cultural emphasis on exam performance(J. Wang & Lin, 2005). Pre-service teachers in such contexts may hold epistemological beliefs that reflect both reform-oriented ideals and traditional exam-driven practices, resulting in tensions that influence their future teaching practices. Yet few studies have empirically examined this intersection.

The present study aims to address these gaps by investigating the relationship between Chinese pre-service mathematics teachers' epistemological beliefs including beliefs about the nature of mathematics and about mathematics learning and teaching, and reform-oriented instructional practices. Focusing on pre-service teachers in Northwest China, this research seeks to provide empirical evidence from a culturally underrepresented context, thereby contributing both to theory and to practice in mathematics teacher education.

LITERATURE REVIEW

Epistemological Beliefs about the Nature of Mathematics

Teachers' epistemological beliefs about mathematics reflect their knowledge and perspectives on the nature of mathematics. More broadly, these are considered to fall into two categories or orientations: traditionalist (or absolutist) and constructivist(fallibilist). The traditionalist view regards mathematics as an unchangeable body of fixed, objective knowledge to be delivered from teacher to student. Teachers holding this viewpoint are more likely to teach according to principles of memorization, procedural fluency, and direct instruction(Ernest, 1989; Perry et al., 2002). In contrast, the constructivist orientation sees mathematics as a human creation—dynamic, evolving, and open to exploration. Such educators choose to place emphasis on reasoning, problem solving, and student inquiry in the classroom (Philipp, 2007; Thompson, 1992).

The literature on mathematics teachers' beliefs has indicated consistently that teachers aligned to these epistemological stances make relevant pedagogical choices as well. For example, traditionalist teachers were found more likely to implement teacher-centered practices that emphasize procedural fluency and correct answer, whereas constructivist ones favored student-centered practices that promote active inquiry and development of thinking processes(Beswick, 2012). The existence of such distinctions highlights that teachers' beliefs are epistemological views that are practical in nature; they determine how teachers might actually teach.

In this sense, investigating pre-service teachers' beliefs regarding mathematics as a subject matter is an important step toward in predicting their future instructional practices in class.

Epistemological Beliefs about Mathematics Learning and Teaching

In addition to beliefs about the nature of mathematics, teachers' epistemological beliefs about mathematics learning and teaching are also central importance to understanding their instructional practices. Teachers' beliefs about learning mathematics tend to work along a spectrum ranging from rote memorization and mastery of procedure to active construction of knowledge. Those who believe learning mathematics entails memorizing facts, rules, and algorithms are likely to encourage repetition of practice and attention to the correct answer. In contrast, those who view learning as an exercise in making sense and constructing meaning are likely to plan tasks that emphasize reasoning, problem solving, and linkages between concepts(Pajares, 1992; Thompson, 1992).

Similarly, beliefs about mathematics teaching shape whether instructional tasks are teacher-directed which stress emphasis on conceptual memorization and standard procedures or student-centered with active thinking and reflection. A teacher-centric orientation is patterned by the transmission model of teaching and learning in which teachers impart knowledge to students usually through lectures and demonstrations. A student-focused orientation suggests the learning happens through facilitation with teachers encouraging inquiry, exploration, and cooperative inquiry. Earlier work suggests that teachers' beliefs about teaching are a strong predictor of the types of student teaching they adopt in their classrooms(Beswick, 2012; Perry et al., 2006). In cross-cultural studies for example, Perry et al. found that teachers who held constructivist beliefs about the nature of teaching were significantly more likely to devote time to exploratory learning activities with students rather than relying exclusively on procedural practice.

These findings highlight that epistemological beliefs do not just work with abstract notions of mathematics per se but also with practical concerns about how mathematics should be undertaken as learning and teaching. In order, therefore, beliefs about how mathematics should be learned and taught form the link between teachers' epistemological principles and classroom instructional behaviors. These beliefs are central among pre-service teachers as clarifying and reflecting on them forms the basis of their formation of professional identity and influences the approaches they take into future classrooms.

Epistemological Beliefs and Instructional Practices

A growing body of research findings demonstrated the clear correlations between teachers' pedagogical practices and their epistemological beliefs. Specifically, traditionalism perceiving mathematics as a set of absolute truths, is more likely to be associated with teacher-centered practices such as rote learning, procedural drill and direct instruction, whereas constructivism is more likely to correlate with student-centered practices such as problem solving, reasoning and inquiry (Ernest, 1989; Philipp, 2007). These constructivist epistemological orientations appear to align well with constructivist instructional dimensions of cognition activation (PCA) and personal learning support (PLS) , which focus on activating students in higher-order thinking, as well as providing responsive support for students' needs.

Empirical research is supportive of these propositions. For instance, based on a very large sample of Chinese pre-service teachers of mathematics, Yang et al.(2020) revealed that epistemological beliefs were more strongly associated with self-reported instructional practices than even mathematical content knowledge. Similarly, Marbán et al. (2021) found that teachers who valued mathematics as dynamic were more likely to adopt inquiry-based instructional practices in their classrooms. The combined findings indicate that teachers' epistemological beliefs can be utilized as strong predictor whether teachers experiment with reform-oriented, student-centered teaching in the classroom, or are committed to traditional, procedural teaching.

Nevertheless, the relationship between beliefs and practices is not always obvious; Beswick (2012)argues that the relationship between beliefs and practices could be moderated by some contextual factors, such as curriculum constraints, cultural expectations and teachers' professional experience. In high-stakes educational systems, teachers may express constructivist beliefs under the new educational reform expectation, but still rely on

procedural teaching due to exam pressures. This complexity illustrated that a conceptual understanding of epistemological beliefs and teaching practices is not sufficient, but rather, the cultural context in which such beliefs are developed and practiced, e.g., in the profession prep of pre-service teachers in China, needs to be examined.

Context of Chinese Pre-service Teacher Education

The context of teacher education in China provides a unique backdrop for understanding the relationship between epistemological beliefs and instructional practices. Pre-service teachers are mainly educated in normal universities or education colleges where the programs give high emphasis on advanced mathematics coursework an provide a depth of mathematical preparation characterized as strong and, in some respects, comparable to that of mathematics majors(Jiang et al., 2022; Yang et al., 2020). Such academically centered model expects the achievement of content knowledge in mathematics with expectation that a teacher needs mastery on mathematics before they can be a teacher. As such, most pre-service teachers graduate with a decent mathematical knowledge but without enough experience in the use of any new or student-centric teaching strategies(Wu, 2025) .

This content dense educational approach has both strengths and limitations. Whereas it improves the teachers' confidence in dealing with the material that is given in mathematics, on the other hand it often leaves insufficient room for forming the beliefs and teaching practices that are consistent with constructivist or inquiry-based approaches. Evidence from well-developed regions indicates that Chinese pre-service teachers sometimes mention tension between their belief in the merit of engaging instruction and the demand to adapt to exam-oriented, teacher-centered classroom practices(Leung, 2001; Liu et al., 2022; Yang et al., 2020) .

Recently, Chinese teacher education reform policies and curriculum reforms(such as the 2011 "Mathematics Curriculum Standards") have been giving emphasis on practicum experiences, reflective modules, and the use of microteaching sessions to strengthen pre-service teachers' professional preparation, encourage inquiry based teaching, problem solving, and student engagement in order to tackle the imbalances(L. Wang et al., 2017).For instance, the Ministry of Education(MOE, 2017) introduced accreditation standards requiring teacher-education institutions to enhance practicum and assessment components. Parallel to these policies, academic studies also confirm a growing emphasis on reflective practice and practicum-based training in teacher education(Y. Wang et al., 2023; Ye et al., 2019).

Nevertheless, the traditional models continue to prevail, and pre-service teachers' epistemological beliefs are still heavily influenced by a Confucian heritage culture of valuing respect for authority, memorization and attaining success on exams(Leung, 2001), and Collectivism with a unified paces. Indeed, China has a well documented exam-oriented, highly procedural teaching culture that often leads teachers to value efficiency and accuracy above inquiry and conceptual understanding(Cai, 2004; Ma, 2010). The reform agenda thus places pre-service teachers into a liminal space of sorts: although a product of a traditional exam-oriented school, teachers are expected to embody and embrace reform-oriented constructivist instructional techniques in their future classrooms. This highlights the necessity to explore whether Chinese pre-service teachers' epistemological beliefs are consonant with, or discordant to, the expectations of reform to inform effective teacher preparation and how their epistemological beliefs interact with their instructional practices, particularly in regions such as Gansu, where resources are limited and exam pressures remain high. Thus, the study investigates the relationship between pre-service mathematics teachers' epistemological beliefs and their reform-oriented instructional practices, namely: beliefs about the nature of mathematics(traditionalist vs. constructivist), beliefs about mathematics learning and teaching(teacher-direction vs. student-active-learning), and instructional practices(cognitive activation and personal learning support).

The research question is as following:

What is the relationship between pre-service teachers' epistemological beliefs about the nature of mathematics (traditionalist vs. constructivist) as well as its learning and teaching, and their reform-oriented mathematics instructional practices (cognitive activation and personal learning support)?

According to this question, we proposed the hypotheses as following:

H1a: Constructivist epistemological beliefs about the nature of mathematics will positively predict pre-service teachers' reform-oriented instructional practices, including cognitive activation (PCA) and personal learning support (PLS).

H1b: Traditionalist epistemological beliefs about the nature of mathematics will not significantly predict reform-oriented instructional practices (PCA, PLS).

H2a: Student-active-learning beliefs about mathematics learning and teaching will positively predict reform-oriented instructional practices (PCA, PLS).

H2b: Teacher-direction beliefs about mathematics learning and teaching will not significantly predict reform-oriented instructional practices (PCA, PLS).

RESEARCH METHODOLOGY

Participants. This study adopted a quantitative, cross-sectional survey design to examine how pre-service mathematics teachers' epistemological beliefs relate to reform-oriented instructional practices in Northwest China. Participants were 635 pre-service mathematics teachers enrolled in normal universities and education colleges. Consistent with the population profile of these programs, the majority were female (~75.6%) and of Han ethnicity (~68.5%), with representation from Hui, Tibetan, and other minority groups; academically, most were third- or fourth-year undergraduates, with smaller proportions of three-year diploma students and postgraduates. Participation was voluntary and anonymous.

Measurement. A Chinese version survey instrument comprising two questionnaires measured on 5-point Likert scales (1 = strongly disagree to 5 = strongly agree) was developed. One is Pre-service Teachers' Mathematics-Related Epistemological Beliefs Survey (PTMREBS) adapted from the Education and Development Study in Mathematics (TEDS-M) questionnaire (cited by Alfaro Víquez & Joutsenlahti, 2021).The questionnaire comprised three domains. Beliefs about the nature of mathematics (BNM) were captured by two subscales: traditionalist (5 items, e.g., "Mathematics is a collection of rules and procedures that prescribe how to solve a problem.") and constructivist (4 items; e.g., "mathematics as discovery, creativity, and meaning-making"); 7 items for teacher-direction mathematics learning and teaching beliefs (BTD; e.g., "Students learn mathematics best by attending to the teacher's explanations."); and 6 items for student-active-learning beliefs(BAL; e.g., "Teachers should encourage students to find their own solutions to mathematical problems even if they are inefficient.").The other is a self-designed questionnaire named Pre-service Teachers' Self-Reported Mathematics Instructional Practices Questionnaire (PTSMIPQ) which was based on scattered items provided by scholars (e.g., Alfaro Víquez & Joutsenlahti, 2021; Baumert et al., 2010; Depaepe & König, 2018; Holzberger et al., 2013; Yang et al., 2020). The questionnaire has two dimensions: the first dimension is Cognitive activation(PCA), which contains 5 items (e.g., "I often ask students to figure out their ways to solve mathematical problems."), and the second dimension is personal learning support(PLS), which contains 6 items (e.g., "I supported students additionally when they needed help.")

Reliability and validity evaluation. The questionnaires used in this study was developed based on previous validated instruments and adapted to fit the context of Chinese pre-service mathematics teachers. To ensure the quality of the instrument, both face validity and content validity were evaluated by ten experts in the fields of mathematics education, educational psychology, and teacher education. Minor wording adjustments were made based on their feedback, and the overall content validity index (CVI>0.78) exceeded the acceptable threshold(Yusoff, 2019), indicating that the items were conceptually clear and relevant to the research constructs. In addition, a pilot study was conducted among a sample of 175 pre-service teachers prior to the main data collection. The results confirmed that the questionnaire had acceptable psychometric properties. Cronbach's alpha coefficients provided an estimate of the internal consistency reliability of individual subscales. The alpha values all exceeded the recommended limit of 0.70 indicating satisfactory reliability of the data. Specifically, Cronbach's alpha values was 0.937 for PTMREBS and 0.901 for PTSMIPQ. Furthermore, construct validity was examined through Exploratory Factor Analysis (EFA) using Unweighted Least Squares (ULS) method with

Kaiser-normalized varimax rotation. The results confirmed the expected factor structure, with all items loading above 0.50(ranging from 0.574 to 0.851 in PTMREBS and 0.568 to 0.801 in PTSMIPQ) on their respective constructs. The Kaiser-Meyer-Olkin (KMO) measure was 0.932 and 0.917 respectively, and Bartlett's Test of Sphericity was significant ($p < .001$), indicating the suitability of the data for factor analysis. The extracted factors collectively explained 68.6% and 64.1% of the total variance respectively, supporting the structural validity of the instrument. These results demonstrate that the questionnaire possessed satisfactory content, construct, and internal consistency reliability, making it a valid and reliable tool for assessing pre-service teachers' mathematics-related epistemological beliefs and instructional practices.

Data collection and analysis. The survey was administered on site and online during the 2024 academic year. After data quality assessment and screening, 635 valid cases were retained. Scale scores were computed as item means. Analyses were conducted in SPSS 26.0. Descriptive statistics summarized central tendency and dispersion; a paired-samples t-test compared BNM-traditionalist versus BNM-constructivist to evaluate the co-endorsement pattern. Bivariate Pearson correlations described zero-order relations among all constructs. To test the hypotheses, two multiple linear regressions were fitted with PCA and PLS as dependent variables and BNM-traditionalist, BNM-constructivist, BTD, and BAL as predictors. Standard diagnostics indicated that assumptions were adequately met: residual normality and homoscedasticity were inspected via standardized residual plots; multicollinearity was minimal (VIFs < 3); and Durbin–Watson statistics (~1.81–1.85) suggested independence of errors. Statistical significance was set at $\alpha = .05$ (two-tailed), and we report standardized β, R^2/Adjusted R^2, F where applicable.

RESULTS AND DISCUSSION

Descriptive statistics

Table 1 presents the descriptive statistics and internal consistency reliability for the study variables. The results indicates that pre-service teachers reported relatively high levels of constructivist beliefs about the nature of mathematics (BNM_cons; M=4.23,SD=0.61). Meanwhile, traditionalist beliefs about mathematics was also highly endorsed (BNM_trad; M=4.13,SD=0.60). Regarding beliefs about teaching and learning mathematics, pre-service teachers endorsed student-active learning beliefs (BAL; M = 4.13, SD = 0.57) more than teacher-direction beliefs (BTD; M = 3.26, SD = 0.89). For instructional practices, participants reported moderately high levels of cognitive activation (PCA; M = 3.84, SD = 0.59) as well as personal learning support (PLS; M = 3.94, SD = 0.59). All Cronbach's alpha coefficients exceeded the .70 threshold (range from.793 to.876), indicating satisfactory to high internal consistency reliability for each scale.

Table1. Descriptive Statistics and Reliability of Key Variables (N = 635)

Variable	Min	Max	Mean	SD	Cronbach's α
BNM_trad	2.00	5.00	4.13	0.60	0.802
BNM_cons	2.00	5.00	4.23	0.61	0.793
BTD	1.29	5.00	3.26	0.89	0.876
BAL	2.33	5.00	4.13	0.57	0.845
PCA	2.20	5.00	3.84	0.59	0.797
PLS	2.17	5.00	3.94	0.59	0.856

In addition, a paired-samples t-test was conducted to compare pre-service teachers' traditionalist and constructivist epistemological beliefs about mathematics. The results showed that while both types of beliefs were strongly endorsed (M_trad = 4.13, SD = 0.60; M_cons = 4.23, SD = 0.61), constructivist beliefs were slightly but significantly higher, $t(634) = –5.97$, $p < .001$. The effect size was small (Cohen's $d = –0.24$), indicating that the magnitude of this difference was modest. Furthermore, the two belief dimensions were highly correlated ($r = .76$, $p < .001$), suggesting that pre-service teachers tended to simultaneously endorse both traditionalist and constructivist views. This pattern implies that their belief system is not strictly dichotomous but rather characterized by a coexistence of multiple perspectives on the nature of mathematics.

Correlational analysis

able 2 presents Pearson correlations among the variables. Firstly, both traditionalist beliefs and constructivist ones on the nature of mathematics had positive correlations with student-active learning beliefs (r = .676, r = .677, respectively, p < .01), indicating that pre-service teachers embracing either traditionalist or constructivist beliefs about mathematics have similar views about mathematics teaching and learning, meaning that they all hold student-active learning beliefs. Constructivist beliefs were positively associated with both PCA (r = .470, p < .01) and PLS (r = .495, p < .01), while traditionalist beliefs also showed significant positive correlations with PCA (r = .439, p < .01) and PLS (r = .475, p < .01). In addition, student-active learning beliefs (BAL) showed a strong relationship with PCA (r =.563, p< .01) and PLS (r =.568, p<.01) while teacher-direction beliefs (BTD) correlated loosely, even negatively, with PCA (r =-.237, p<.01) and PLS (r =-.201, p<.01). Finally, PCA and PLS were demonstrated to be closely correlated (r =.758, p<.01) showing their conceptual compatibility as teacher instruction practice. Taken together, this evidence suggest that constructivist and student-active learning beliefs are more compatible with constructivist reform instructional practices. By contrast, teacher-direction beliefs is inhibiting reform practices.

Table 2. Correlations Among Key Study Variables (N = 635)

Variable	BNM_trad	BNM_cons	BTD	BAL	PCA	PLS
BNM_trad	1	.759**	.258**	.676**	.439**	.475**
BNM_cons	.759**	1	.166**	.677**	.470**	.495**
BTD	.258**	.166**	1	.292**	-.237**	-.201**
BAL	.676**	.677**	.292**	1	.563**	.568**
PCA	.439**	.470**	-.237**	.563**	1	.758**
PLS	.475**	.495**	-.201**	.568**	.758**	1

Note. **p < .01 (2-tailed).

Multiple regression analysis

To further examine the unique contributions of teachers' epistemological beliefs to instructional practices, two multiple regression analyses were conducted, with cognitive activation (PCA) and personal learning support (PLS) as dependent variables. Predictor variables included traditionalist and constructivist beliefs about the nature of mathematics (BNM_trad, BNM_cons), teacher-direction beliefs (BTD), and student-active learning beliefs (BAL).

Table 3a presents the results of a multiple linear regression predicting PCA. The overall regression model was statistically significant, $F(4, 630) = 80.631$, $p < .001$, explaining 33.9% of the variance in PCA scores ($R^2 = .339$). Among the predictors, student-active learning beliefs (BAL) emerged as the strongest positive predictor ($\beta = .422$, $p < .001$), followed by constructivist beliefs about the nature of mathematics (BNM_cons; $\beta = .166$, $p = .002$). Teacher-direction beliefs (BTD) also contributed a small but significant effect ($\beta = .085$, $p = .013$). In contrast, traditionalist beliefs (BNM_trad) were not significant ($\beta = .006$, $p = .912$). Multicollinearity was not a concern, as all VIF values were below 3.

These results support H1a and H2a, confirming that pre-service teachers who hold constructivist epistemological beliefs and student-active learning beliefs are more likely to adopt cognitively activating instructional strategies. In contrast, H1b is supported because traditionalist beliefs did not significantly predict PCA, while H2b is only partially supported, as teacher-direction beliefs showed a weak but significant positive association rather than the expected nonsignificant or negative effect.

Table 3a. Multiple Linear Regression Predicting Cognitive Activation (PCA)

Predictor	B	SE B	β	t	p	VIF
(Constant)	1.172	.153	—	7.647	< .001	—
BNM_trad	.006	.052	.006	.111	.912	2.709

BNM_cons	.159	.051	.166	3.119	.002	2.701
BTD	.056	.022	.085	2.485	.013	1.116
BAL	.434	.049	.422	8.842	< .001	2.169

Model summary: $R = .582$, $R^2 = .339$, Adjusted $R^2 = .334$, $F(4, 630) = 80.631$, $p < .001$

Table 3b displays the results of a multiple linear regression predicting PLS. The model was also significant, $F(4, 630) = 84.310$, $p < .001$, explaining 34.9% of the variance in PLS ($R^2 = .349$). Student-active learning beliefs (BAL) were the strongest positive predictor ($\beta = .395$, $p < .001$), followed by constructivist beliefs about mathematics (BNM_cons; $\beta = .167$, $p = .002$). In contrast, traditionalist beliefs (BNM_trad; $\beta = .071$, $p = .181$) and teacher-direction beliefs (BTD; $\beta = .040$, $p = .239$) did not significantly predict PLS after controlling for the other variables. All VIF values were below 3, suggesting no multicollinearity issues among predictors.

These findings again support H1a and H2a, confirming that teachers who value constructivist and student-active learning approaches tend to provide stronger personal learning support. Meanwhile, H1b and H2b are also supported, as traditionalist and teacher-directed beliefs failed to predict PLS.

Table 3b. Multiple Linear Regression Predicting Personal Learning Support (PLS)

Predictor	**B**	**SE B**	**β**	**t**	**p**	**VIF**
(Constant)	1.174	.154	—	7.607	< .001	—
BNM_tra	.070	0.052	.071	1.338	.181	2.709
BNM_con	.163	.051	.167	3.167	.002	2.701
BTD	.027	.023	.040	1.177	.239	1.116
BAL	.412	.049	.395	8.337	< .001	2.169

Model summary: $R = .590$, $R^2 = .349$, Adjusted $R^2 = .345$, $F(4, 630) = 84.310$, $p < .001$

DISCUSSION

The present study aimed to investigates the the relationship between pre-service teachers' epistemological beliefs about the nature of mathematics as well as its learning and teaching, and their reform-oriented mathematics instructional practices. Correlational analysis and Multiple regression analysis were conducted to explore the correlations between variables.

Consistent with H1a and H2a, both constructivist epistemological beliefs about the nature of mathematics and student-active learning beliefs positively predicted pre-service teachers' cognitive activation (PCA) and personal learning support (PLS). This finding aligns with a growing body of research showing that teachers who perceive mathematics as a dynamic and meaning-making discipline are more likely to adopt inquiry-based, student-centered approaches(Beswick, 2012; Marbán et al., 2021; Russo et al., 2020). From the lens of social constructivist theory(Vygotsky, 1981) , these teachers emphasize collaborative meaning-making and the co-construction of mathematical knowledge through dialogue and exploration. Such orientations align with cognitive activation practices that engage students in reasoning, discussion, and problem solving.

In contrast, H1b and H2b were supported as traditionalist and teacher-direction beliefs did not significantly predict either PCA or PLS. This result suggests that holding more absolutist, knowledge-transmission views of mathematics may not directly translate into active or supportive teaching behaviors. Such beliefs often frame mathematics as a fixed body of facts and procedures(Ernest, 1989; Staub & Stern, 2002), leading to instructional approaches that prioritize accuracy and authority over exploration and discussion(Johnston et al., 2021; Yujiao et al., 2024).

However, it is noteworthy that teacher-direction beliefs showed a weak but significant association with cognitive activation, contrary to the initial hypothesis. This may reflect the unique educational culture in China, where direct instruction and student engagement are not always viewed as oppositional but rather as complementary. In many Chinese classrooms—particularly in western provinces such as Gansu—teachers tend to integrate

structured, teacher-led explanations with moments of student participation and guided exploration. This hybrid approach reflects a balance between the traditional Confucian emphasizing on authoritative knowledge transmission, the virtue of diligence and the value harmony and balance, and contemporary reforms that encourage student engagement and inquiry. Research on Chinese mathematics instruction has shown that while teaching often remains highly organized and teacher-directed, it increasingly incorporates opportunities for discussion, variation practice, and collective problem-solving (Kaiser & Presmeg, 2019; Zhang, 2022).Effective lessons in China frequently combine explicit explanation of mathematical principles with structured questioning and peer collaboration (Fan et al., 2015). Similarly, Zhang (2022) observed that secondary mathematics teachers in mainland China often employ mixed strategies—balancing direct instruction with opportunities for students to reason and communicate mathematically—reflecting an evolving form of "cultural hybridization" in teaching practices. Such patterns are particularly pronounced in regions like Gansu, where teachers negotiate between examination-oriented expectations and the growing emphasis on student-centered learning within national curriculum reforms. Thus, modestly teacher-led instruction can still coexist with cognitively activating strategies, reflecting a culturally adapted form of constructivism.

CONCLUSION AND IMPLICATIONS

The present study examined how pre-service teachers' epistemological beliefs about mathematics-specifically their views of the nature of mathematics (traditionalist vs. constructivist) and beliefs about mathematics learning and teaching (teacher-direction vs. student-active-learning)-predict their instructional practices, including cognitive activation (PCA) and personal learning support (PLS). In conclusion, the results indicated that constructivist and student-active-learning beliefs significantly enhance pre-service teachers' inclination toward reform-oriented instructional practices, whereas traditionalist and teacher-direction beliefs exert little or no influence. The findings of this study offer an initial outline for the further exploration of the relationship between the epistemological beliefs of mathematics teachers and their instructional practices, especially on the context of northwest China. From an explorative perspective, through understanding and examining interrelationships between beliefs and , the current study provided the first kind of empirical evidence, which helped to fill a research gap in that area.

However, there still exist several limitations that need to be considered. First of all, we choose a cross-sectional survey design. This may pose limitations because it precludes us from making additional investigation with respect to depth seeking and examining the relation or accounting for the causal relationship underlying associations between beliefs and practice. Because of richness of belief systems, as well as the dynamic nature of instructional practices, depending only on a quantitative approach may well not have been sufficient; may lack being able to explain the complex ways beliefs are constructed, negotiated and then implemented within the instructional space. Future studies can utilize qualitative approaches, namely: class observer method, semi-structured interviews or grounded theory, to triangulate existing studies' findings and elicit further details. Finally, adopting longitudinal or mixed-methods design, will allow researchers to trace the development of pre-service teachers' beliefs during their in-schooling process of learning/practicing for the early years of their working life.

Secondly, the present study omitted from consideration potential mediating or moderating variables that might have offered further explanation concerning mechanisms underlying interconnections among epistemological beliefs and instructional practice. Factors such as teaching self-efficacy, mathematical anxiety, or perceived supportive policy environment might serve important mediation functions. Inclusion of these constructs within future structural modelling might lead to a more holistic portrait with respect to how beliefs translate into pedagogic action. Furthermore, cultural and contextual factors such as existing local education cultures, ethnic differences, and institutional traditions might also be driving forces towards both beliefs and practices. Although consequences arising from Confucian ways of thinking and the examination driven cultural background of the country at large were alluded to in brief terms during the authors' original conceptions, no specific ethnically or regionally specific cultured characteristics were considered within the current study. Future explorations should examine how varying cultural backgrounds within China-some specifically belonging to various minority communities living in western regions-impacts pre-service teachers' epistemologies pertaining to mathematics-or, ultimately, towards teachers' attitudes towards teaching mathematics in general.

Lastly, although provisioned measurement instruments showcased robust reliability and validity, self-reported information inevitably comes with its own set of social desirability biases and does not necessarily capture teachers' real classroom behaviours. Future investigations might incorporate observational analyses together with performance-based measurements that would attest to whether or not there is congruency amongst teachers' aforementioned beliefs and the extant practices.

Overall, notwithstanding the abovementioned limitations, this current study serves as a useful empirical springboard to guide others away forward. The use case emphasises awareness around the cultural and contextual heterogeneity inherent to teacher education within China, and a further up-and-continual investigation using multiple methods that comprehensively accounts for how beliefs underlie the nature of teaching reforms and teachers' professional learning across diverse contexts and backgrounds.

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