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Effect of Epistemological Belief on Teaching Efficacy: A Survey of Gandaki Province of Nepal

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Abstract

The research aimed to identify the status of mathematics teachers' epistemological beliefs and teaching efficacy, as well as the effect of epistemological beliefs on teaching efficacy. This cross-sectional survey was conducted among 267 secondary-level mathematics teachers working in community schools in Gandaki Province, Nepal. The major statistical techniques employed in the research were the t-test, one-way ANOVA, and hierarchical multiple regression to analyze the data. The findings indicated that the level of mathematics teachers in epistemological beliefs and teaching efficacy, as well as age, academic background, qualification, and experience, plays a significant role in shaping epistemological beliefs and teaching efficacy, which is found to be significantly high. The results further show that epistemological belief significantly predicts teaching efficacy.

Keywords: epistemological beliefs, teaching efficacy, mathematics teacher, secondary level, Nepal

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Introduction

Personal schemas and perspectives related to concepts and phenomena guide behavior and influence actions. Beliefs about the nature of knowledge, its acquisition, and confidence in teaching have a significant impact on teaching behavior and performance. Beliefs are psychologically held understandings and assumptions considered true, shaping how individuals communicate and interact with the world (Voss et al., 2013). Teacher beliefs encompass various areas, including teaching and learning, instruction, subject matter, and cultural diversity (Calderhead, 1996; Hoy & Pape, 2006; Muis, 2004). Among these, epistemological belief refers to individual conceptions about the nature of knowledge and its acquisition, including views on mathematics as absolutist, formalist, logistic, or fallibilist (Depaepe et al., 2016). Teaching efficacy, defined as teachers' self-confidence in teaching, particularly in mathematics, is closely related to epistemological beliefs (Lee & Devis, 2014). Epistemological beliefs have been studied extensively since Perry's pioneering work (1968, 1970) and Schommer's formal research (1990), revealing how individuals perceive the certainty, source, and development of knowledge (Schommer, 2004; Hofer & Pintrich, 1997). These beliefs mature with cognitive development and vary across disciplines and individuals (Blomeke et al., 2008; Chrysostomou & Philippou, 2010; Ekinci, 2017; Hofer et al., 1997).

In mathematics education, epistemological beliefs are often framed within absolutist and fallibilist perspectives (Ernest, 2014). Absolutists view mathematical knowledge as certain, static, and discovered rather than invented (Sherry, 1997), whereas fallibilists consider it tentative, socially constructed, and open to revision (Hersh, 1997; Dummett, 1991). Both views hold legitimacy, and teachers' epistemological beliefs influence their teaching confidence and practices (Blomeke et al., 2008). Research consistently shows a significant relationship between epistemological beliefs and teaching efficacy (Chrysostomou & Philippou, 2010; Maravilla & Gomez, 2015; Tezci et al., 2016). Demographic factors such as gender and educational background also impact teaching efficacy (Sarfo et al., 2015; Alwaleedi, 2016). Epistemological beliefs influence teaching behaviors and student learning, and they vary by subject, level, and culture (Schommer, 2004; Bendixen & Rule, 2004; Hofer, 2001; Felbrich et al., 2012). However, research on this topic in the context of secondary mathematics education in Nepal remains limited, underscoring the relevance of the present study, which was conducted in Gandaki Province using a cross-sectional survey design. Moreover, the study was conducted to test the following research hypothesis.

H_1: Mathematics teachers have more than average epistemological beliefs about mathematics.

H_2: Epistemological beliefs differ significantly across age groups, qualifications, academic background, and experience.

H_3: Mathematics teachers have more than average teaching efficacy about mathematics.

H_4: Teaching efficacy differs significantly across age groups, qualifications, academic background, and experience.

H_5: Epistemological beliefs have a significant effect on teaching efficacy.

Theoretical Models on Epistemological Belief

The central theories and models of epistemological belief, which concern the nature of knowledge and the knowledge acquisition system related to that study, are summarized here. These theories and models were used to prepare the measurement tools and analyze the results. However, epistemological beliefs in mathematics are categorized into two major parts: absolutism and fallibilism (Earners, 2014).

Perry described the four stages of epistemological belief. Dualistic, multi-plastic, relativism, and commitment to relativism are stages of epistemological belief (Perry, 1970). Among the four stages, the first stage is related to the absolutist view on mathematics, and the other is related to the fallibility philosophy of mathematics. By considering people as a knower, silent knowing, received knowledge, subjective knowing, procedural knowing, and constructed knowing are described as ways of knowing (Blenky et al., 1986). Among these, the first three are linked with absolutist epistemological beliefs about mathematics, and the rest are linked with fallibilist epistemological beliefs about mathematics. The existence of knowledge is a significant concern regarding epistemological beliefs. The reflective judgment model explains three levels of knowledge existence. Pre-reflective, quasi-reflective, and reflective are three such levels of epistemological belief (King & Kitcher, 1994). Absolutist, multiplicity, and evaluative are three categories of epistemological belief. In the realm of knowing, there are five primary ways of knowing: absolute knowing, transitional knowing, independent knowing, contextual knowing, and way of knowing (Mogolda, 1992). Khun's theory describes the nature of knowledge. It explained absolutism, multiple, and evaluationist as epistemological beliefs (Hofer, 2001).

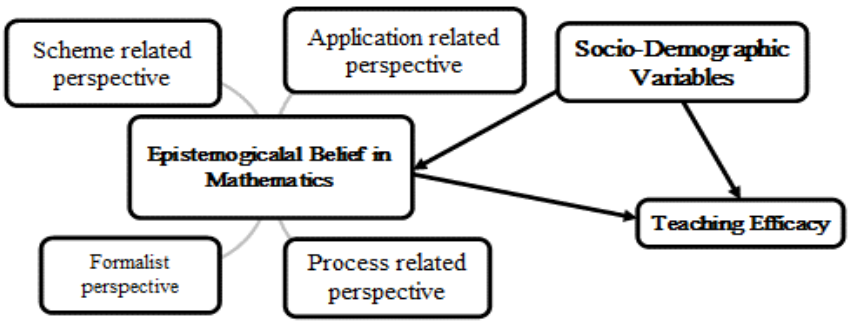
Conceptual Framework

The conceptual framework was organized according to the researchers' understanding of how the particular variables were interconnected in the study. Demographic variables, including gender, age, experience, qualification, and academic stream/field, are considered independent variables, while epistemological belief and teaching efficacy are dependent variables used to determine the status of epistemological belief and teaching efficacy. The scheme-related perspective, formalist perspective, process-related perspective, and application perspective are the epistemological belief dimensions regarding mathematics. Among them, the first two are under the infallible philosophy of mathematics, and the last two are under the fallible philosophy of mathematics. Efficacy for instruction,

efficacy for motivation, efficacy for classroom management, and efficacy for student engagement are the four key dimensions of teaching efficacy. Overall epistemological beliefs and their four dimensions are considered independent variables, and teaching efficacy is the dependent variable to examine the effect of epistemological beliefs on teaching efficacy. The further details of the conceptual framework are presented in Figure 1.

Figure 1

Conceptual Framework



Method

This study employed a cross-sectional survey design among mathematics teachers at the school level in Gandaki province. The total population for the study consisted of 810 mathematics teachers; hence, the representative sample size for this population was 261 (William, 1997) since the 267 mathematics teachers (Teaching at Grade 9 and 10) who participated in this study ensured the representativeness of the sample size for the research.

Self-constructed instruments, such as the epistemological belief measurement scale and teaching efficacy scale, were used in this research, which were developed based on different theoretical literature. The epistemological belief measurement scale was developed under the guidance of previously prepared epistemological belief inventory scales (Schommer, 1990). The scale consists of 24 items measured on a five-point scale from strongly disagree to agree strongly. Similarly, the teaching efficacy scale consists of 24 items, which were also measured on a five-point scale, ranging from "never" to "always." The tool was piloted among 30 mathematics teachers at the same level to ensure validity and reliability. The Cronbach's Alpha value of the epistemological belief measurement and teaching efficacy scale was found to be greater than 0.70 (the threshold value), which ensures the reliability of the scales (Cronbach, 1990). Additionally, the validity of the instruments was ensured by content, face, and convergent validity methods. The content and face validity were ensured by sharing the tool with Mathematics Education-related experts and incorporating their suggestions and feedback before piloting. Moreover, convergent

validity was ensured by the parallel form method, and the Spearman correlation coefficient of the parallel test was found to be greater than 0.70 (the threshold value), which confirms the convergent validity (Marcle, 2016).

Data were collected through both face-to-face and online modes, with informed consent information for the participants included in the instrument. Data were cleaned and prepared by coding the response variables using numerals and calculating the mean. The variables, epistemological belief and its dimensions, teaching efficacy and its dimensions, are scaled and follow the normal distribution. Hence, the mentioned variables were suitable for using the parametric test.

The data were analyzed by using the Statistical Package for Social Sciences (SPSS). A single mean t-test was employed to identify the status of teachers' epistemological beliefs and teaching efficacy. An independent t-test was employed to identify the effect of age, qualification, and academic background. ANOVA was used to investigate the effect of experience on epistemological beliefs and teaching efficacy. Linear regression and multiple hierarchical regression were employed to investigate the effect of epistemological belief on teaching efficacy across various domains.

Result

The sample's socio-demographic characteristics, including age, educational background, and teaching experience, are summarized in Table 1. Female participants were only 3.4%, while males comprised 96.6%. Nearly two-thirds (65.9%) of teachers were aged 20–40, indicating a younger workforce in secondary mathematics teaching.

Table 1

Information of Socio-demographic Characteristics (n=267)

Socio-demographic characteristics	Categories	n	Percentage
Gender	Male	9	3.4
	Female	258	96.6
Age group in year	20-39	176	65.9
	40 and above	91	34.1
Academic Qualification	Bachelor degree	66	24.7
	Master degree	201	75.3
Experience in year	0-5	62	23.2
	5-10	65	24.3
	10-15	68	25.5
	15-20	42	15.7
	20 and more	30	11.2
Academic stream/field	Education	211	79
	others	56	21

Most teachers (75.3%) held a master's degree, exceeding the minimum qualification requirements. Less than one-fourth of the teachers had fewer than five years of experience,

while the majority had over ten years. Regarding their educational background, 79% of teachers came from the field of education, with the remaining 21% from other fields, such as science, management, and humanities.

Each item of the epistemological belief and teaching efficacy scales was analyzed using mean and standard deviation, summarized in Figures 2 and 3. The overall mean epistemological belief score was 3.80 (SD = 0.28), indicating that mathematics teachers generally hold strong, consistent epistemological beliefs about mathematics. All dimensions scored above 3 with relatively low standard deviations, showing agreement among respondents: scheme-related (M = 3.46, SD = 0.64), formalist (M = 3.62, SD = 0.47), application (M = 4.18, SD = 0.52), and process-related perspectives (M = 3.19, SD = 0.47). Similarly, the infallible (M = 3.52, SD = 0.49) and fallible perspectives (M = 4.07, SD = 0.43) also scored above 3 with low variability. These results suggest that teachers possess predominantly positive epistemological beliefs regarding mathematics.

Figure 3

Epistemological belief dimensions summary

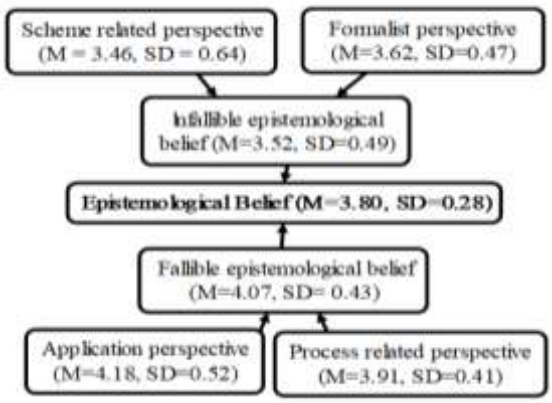
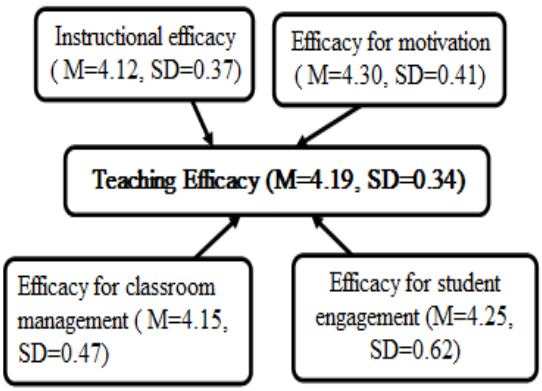


Figure 2

Teaching efficacy dimensions summary



The mean scores for the dimensions of teaching efficacy were all above 3 with low variability, indicating positive self-efficacy among mathematics teachers: efficacy for instruction (M = 4.12, SD = 0.37), motivation (M = 4.30, SD = 0.41), classroom management (M = 4.15, SD = 0.47), and student engagement (M = 4.25, SD = 0.62). The overall teaching efficacy score was also high (M = 4.19, SD = 0.34), with standard deviations below 1, showing convergence within the sample (Table 10). However, items related to pedagogical approach, such as emphasis on memorization (M = 3.90, SD = 0.92), teaching to find correct answers (M = 3.70, SD = 1.22), and following textbook examples for problem-solving (M = 3.49, SD = 1), had comparatively lower means, suggesting teachers place less focus on rote memorization in problem-solving.

Status of Epistemological Belief

The identification of whether the mathematics teachers' epistemological beliefs about mathematics are strong or poor was the concern of the study.

Table 2

T-test Result of Epistemological Belief and Teaching Efficacy (n=267)

Single Mean t-test (test value = 3)				
Variables	Mean	SD	t-value	Sig*
Epistemological belief	3.80	0.278	47.24	0.000
Teaching efficacy	4.19	0.34	57.3	0.00
Independent t-test				
Variables				
Fallible belief	4.07	0.43	12.40	0.000
Infallible belief	3.52	0.49		

*Significance p<0.05

This case was studied under the research hypothesis, " H_1: Mathematics teachers have more than average epistemological beliefs about mathematics". A t-test was used to test the hypothesis. To test this hypothesis, the test value equal to 3 was taken because in a five-point Likert scale, the average was 3, and an independent t-test was used to test the majority inclination on belief. The result of the one-sample t-test is given in Table 2.

The t-test results indicate that mathematics teachers have epistemological beliefs about mathematics that are significantly above average ($t(266) = 47.24$, $p < 0.05$) with equal variances assumed. Additionally, the comparison between fallible and infallible epistemological beliefs reveals a significant difference ($t_{(266)} = 12.40$, $p < 0.05$), with teachers showing a stronger inclination toward the fallible perspective of mathematics. To examine differences in epistemological beliefs across socio-demographic variables, independent t-tests were conducted for age group and academic background, each divided into two groups. For teaching experience, classified into five groups based on five-year intervals, a one-way ANOVA was used to assess significant differences. The combined results demonstrate variations in teachers' epistemological beliefs relative to these factors.

The research hypothesis (H_2) proposed that epistemological beliefs about mathematics differ significantly across age groups, qualifications, academic streams, and teaching experiences. The result showed no significant differences in epistemological beliefs based on age group ($t_{(265)} = 1.55$, $p = 0.12$), academic background ($t_{(265)} = 0.72$, $p = 0.47$), or qualification level ($t_{(265)} = 1.09$, $p = 0.27$). Additionally, one-way ANOVA results indicated no significant difference in epistemological beliefs across five experience groups ($F_{(4, 262)} = 1.07$, $p = 0.347$). These findings suggest that mathematics teachers' epistemological beliefs are consistent across these demographic variables. The details were as shown in Table 3.

Table 3

Comparison of Epistemological Belief-Based and Teaching Efficacy across Socio-demographic Variables (n=267)

Dependent Variable →		Teaching Efficacy				Epistemological belief			
Independent variables	n	Mean	SD	t/f- Stat	Sig*	Mean	SD	t/f- Stat	Sig*
Age groups in year									
20-39	176	3.82	0.29	1.55	0.12	4.21	0.33	1.45	0.15
40 and above	91	3.77	0.26			4.15	0.34		
Academic stream									
Education	211	3.81	0.28	0.72	0.47	4.19	0.33	0.017	0.98
Others	56	3.78	0.27			4.19	0.36		
Academic Qualification									
Bachelor	66	3.83	0.27	1.09	0.27	4.20	0.39	0.34	0.73
Master	201	3.79	0.28			4.18	0.32		
Experience in year									
1-5	62	3.83	0.27	1.07	0.37	4.25	0.33	0.73	0.51
5-10	65	3.80	0.28			4.18	0.34		
10-15	68	3.82	0.29			4.17	0.31		
15-20	42	3.80	0.27			4.17	0.31		
20 and more	30	3.71	0.24			4.15	0.40		

*Significance $p < 0.05$

Regarding teaching efficacy, the study examined whether mathematics teachers exhibit above-average teaching efficacy, as indicated by a test value of 3 on a five-point Likert scale. The results from a one-sample t-test supported this hypothesis, indicating that teachers generally possess strong teaching efficacy in mathematics. The details were as shown in Table 2.

The test results ($t_{(266)} = 57.03$, $p < 0.05$) indicate that mathematics teachers possess teaching efficacy above the average level. Specifically, secondary-level mathematics teachers demonstrated strong teaching efficacy across multiple dimensions, including instructional efficacy (M = 4.19), motivational efficacy (M = 4.12), classroom management efficacy (M = 4.30), and student behavior management (M = 4.25). The overall teaching efficacy mean was also high (M = 4.19), further supporting this conclusion.

To examine differences in teaching efficacy across demographic variables, an independent t-test was employed for age group and academic background, each divided into two categories. For teaching experience, classified into five groups based on five-year intervals, a one-way ANOVA was applied to assess significant differences. The combined results indicate how these variables relate to teaching efficacy among mathematics teachers. The null hypothesis stated that teaching efficacy does not differ significantly across age groups,

academic backgrounds, qualifications, or experience. The test results showed no significant differences in teaching efficacy among these groups. Specifically, independent t-tests revealed no significant differences by age group ($t(265) = 1.45$, $p = 0.15$), academic background ($t(265) = 0.17$, $p = 0.98$), or qualification level ($t_{(265)} = 0.34$, $p = 0.73$). Additionally, one-way ANOVA showed no significant difference across experience groups $F_{(4, 262)} = 0.73$, $p = 0.51$). Therefore, the teaching efficacy of secondary-level mathematics teachers does not vary significantly according to age, academic background, qualification, or years of experience. The details were as shown in Table 3.

Effect of Epistemological Belief on Teaching Efficacy

A two-stage hierarchical multiple regression was conducted to examine predictors of teaching efficacy. In the first stage, socio-demographic variables (age, academic stream/field, qualification, and experience) were entered to control for their effects. This model was not significant, $F_{(8, 258)} = 0.40$, $p = 0.94$, indicating that these socio-demographic factors did not predict teaching efficacy.

In the second stage, dimensions of epistemological belief were added while controlling for socio-demographics. This model was significant, $F_{(12, 254)} = 6.79$, $p < 0.001$, explaining 24% of the variance in teaching efficacy (significant change in R^2). Thus, epistemological beliefs significantly predict teaching efficacy.

Specifically, among epistemological dimensions, the formalist perspective ($\beta = 0.10$, $p = 0.03$) and process-related perspective ($\beta = 0.30$, $p < 0.001$) significantly contributed to explaining teaching efficacy, whereas scheme-related ($\beta = 0.03$, $p = 0.59$) and application perspectives ($\beta = 0.06$, $p = 0.37$) did not.

The result presented in Table 4 shows a significant effect of epistemological belief dimensions, but does not clarify how much effect the dimensions have on teaching efficacy. It also does not answer which items of the scale significantly predicted teaching efficacy. To address these unanswered issues, further investigation is needed.

Hierarchical multiple regression was used to identify the effects of epistemological belief and teaching efficacy on mathematics. The items of epistemological belief and their dimensions were predictors, and teaching efficacy was the dependent variable. The functioning variable was normal and had no outliers. The items of epistemological belief were on an ordinal scale, and teaching efficacy was on a continuous scale. This meets the first main assumption of using simple linear regressions as well as hierarchical multiple regression.

Table 4

Effect of Epistemological Belief Dimensions on Teaching Efficacy

IV	Model 1					Model 2				
	Coefficient			Collinearity Statistics		Coefficient			Collinearity Statistics	
	B	β	t	TOL	VIF	B	β	t	TOL	VIF
Cons	4.20		12.61			2.19		5.46		
Age	-0.00	-0.01	-0.07	0.15	6.66	0.02	0.04	0.26	0.15	6.74
AF	0.00	0.00	0.02	0.99	1.01	0.01	0.10	0.26	0.97	1.02
Qua	-0.00	0.05	-0.06	0.93	1.07	0.05	0.06	1.00	0.88	1.13
Ex_1	0.08	0.19	0.81	0.98	3.86	0.05	0.06	0.61	0.25	3.87
Ex_2	0.01	0.00	0.10	0.46	0.13	0.02	0.02	0.28	0.46	0.16
Ex_4	0.00	0.00	0.10	0.56	0.76	0.02	0.02	0.31	0.56	0.78
Ex_5	-0.01	0.01	-0.12	0.37	0.64	0.05	0.04	0.53	0.36	0.72
Scheme						0.02	0.03	0.52	0.72	1.39
Formalist						0.10	0.13*	2.14	0.76	1.31
Process						0.31	0.47*	7.29	0.73	1.38
Application						0.04	0.06	0.93	0.74	1.35
R^2	0.011					0.24				
R^2 change	0.011					0.23				
F- for R^2 change	0.36					19.44				
ANOVA result	$F_{(8,258)} = 0.40$					$F_{(12,254)} = 6.79$*				

*P< 0.05, (Significant)

Dependent variable: teaching efficacy

The tolerance values ranged from 0.498 to 0.965, and VIF values between 1.0063 and 2.009 indicated no multicollinearity issues. The Durbin-Watson value of 1.988, within the acceptable range of 1.5–2.5, showed no autocorrelation problems.

In the hierarchical multiple regression, Model 1 included scheme-related perspective items predicting teaching efficacy, explaining 6% of variance ($F_{(7,259)} = 2.348$, $p < 0.05$), with "Mathematical knowledge follows universally accepted rules" as a significant predictor ($\beta = 0.13$). Model 2 added formalist perspective items and explained 18.3% variance ($F_{(12,254)} = 4.751$, $p < 0.001$), with significant predictors including "Good teachers teach what is important for tests" ($\beta = 0.15$), "Mathematics is a static absolute body of knowledge" ($\beta = 0.19$), and others. The understanding of logic and the learning process was the strongest predictor in this model.

Model 3 incorporated scheme-related, formalist, and application perspectives, explaining 23.9% of variance ($F(17,249) = 4.589$, $p < 0.001$). Significant predictors included "Good teachers teach what is important for tests" ($\beta = 0.16$) and "Mathematics is a static absolute body of knowledge" ($\beta = 0.15$), with the latter being the best predictor.

Table 5

Effect of Epistemological Belief on Teaching Efficacy

Dimensions and items theme	Model 1		Model 2		Model 3		Model 4	
	β	VIF	β	VIF	β	VIF	β	VIF
Scheme-related perspective								
The mathematical activity has a certain rule.	0.09	1.1	0.04	1.1	0.03	1.13	0.03	1.2
Mathematics follows the universal rule.	0.13*	1.2	0.07	1.1	0.06	1.11	0.03	1.2
Mathematics is a Static absolute body of knowledge.	-0.07	1.4	-0.03	1.5	-0.04	1.49	-0.05	1.6
Mathematics consists of jargon.	-0.03	1.1	0.02	1.3	0.07	1.43	0.03	1.5
Mathematics is error-free.	-0.11	1.6	-0.02	1.7	-0.01	1.73	-0.01	1.8
Mathematics has timeless validity.	-0.05	1.3	-0.05	1.4	-0.05	1.37	-0.02	1.4
Learning is getting the right answer.	0.11	1.3	0.15*	1.4	0.16*	1.41	0.16*	1.4
Formalist perspective								
Understanding of logic and process for learning.			0.19**	1.2	0.15*	1.24	0.13*	1.4
Focus learners' practice on mathematics.			0.15*	1.1	0.12*	1.18	0.09	1.2
A teacher is a source of mathematical knowledge.			0.03	1.4	0.04	1.53	0.04	1.6
Good teaching is exam-oriented instruction			-0.18*	1.6	-0.14	1.78	-0.03	2.1
Provides examples of problem-solving			0.12*	1.1	0.07	1.20	0.06	1.3
Application perspective								
Mathematics uses very day words					0.05	1.21	0.03	1.3
Use multiple ways of interpreting mathematics					0.10	1.30	0.10	1.4
Variety in mathematical knowledge as civilization					0.01	1.08	0.00	1.1
Teaching for creating new knowledge					0.15*	1.48	0.07	1.7
Mathematics is useful to solve a social problem					0.14*	1.09	0.07	1.3
Process related perspective								
Using multiple ways of solving the problem							0.03	1.5
Use trial and error method in math's teaching							0.01	1.7
Valuing students feeling shown in the classroom							0.10	1.6
Learning focuses on the self-understanding of math's							-0.05	1.5
Collaboration and cooperation in learning							0.18**	1.4
Mathematics is a creative subject.							0.07	1.5
Mathematics is a human creation							0.13*	1.5
R Square	0.06		0.18		0.23		0.31	
R^2 Change	0.06		0.12		0.05		0.07	
F for R^2 change	2.34*		7.68*		3.61*		3.63*	

*P< 0.05, **P<0.01(Significant)

Dependent variable: teaching efficacy

The final Model 4, which included all four perspectives, explained 31.1% of the variance ($F_{(24,242)} = 4.553$, $p < 0.001$). Significant predictors were "Good teachers teach what is important for tests" (β = 0.16), "Mathematics is a static absolute body of knowledge" (β = 0.13), and "Mathematics learning promotes learners' self-understanding" (β = 0.18), with the latter as the strongest predictor. The adjusted R^2 was 0.243, indicating that epistemological beliefs explained 24% of the variance in teaching efficacy.

Overall, results showed that mathematics teachers possess beneficial epistemological beliefs and teaching efficacy, favoring fallibilist beliefs about mathematics. Socio-demographic variables did not significantly influence these constructs. Hierarchical regression confirmed that epistemological beliefs significantly predict teaching efficacy.

Discussion

This study aimed to examine the status of mathematics teachers' epistemological beliefs, teaching efficacy, and their interrelationship. The mean epistemological belief score exceeded the neutral midpoint, with a one-sample t-test confirming that teachers hold beneficial beliefs favoring a fallibilist view of mathematics. This finding aligns with earlier work by Hofer (1999) and Chrysostomou and Philippou (2010), as well as more recent studies emphasizing the importance of teachers' epistemological sophistication for instructional quality (Smith & Brown, 2021). The high educational level of participants (over 75% holding master's degrees) likely contributed to this positive stance, consistent with Blomeke et al. (2008) and recent evidence linking advanced qualifications with enhanced epistemological development (Garcia & Martinez, 2023). Moreover, fallibilist beliefs showed greater consistency than infallible beliefs, reflecting contemporary perspectives that view mathematical knowledge as dynamic and evolving (Nguyen & Tran, 2020).

No significant differences in epistemological beliefs were observed across age, academic background, or qualification. This concurs with the findings by Buelh et al. (2002) but contrasts with those of Felbrich et al. (2012) and Roesken et al. (2011), likely due to contextual and cultural factors, as well as the low female representation in the sample, which patterns similarly to those noted in cross-cultural research (Kumar & Chen, 2023). The homogeneity across age groups may be attributed to the predominance of younger teachers (20–40 years). The largely master's-qualified sample further explains this uniformity, consistent with recent findings that educational level mediates epistemological beliefs more than demographic variables (O'Connor et al., 2024).

Teachers demonstrated strong teaching efficacy, consistent with Chrysostomou and Philippou (2010). The prevalence of in-service training and the majority's professional teaching background (79%) likely enhanced efficacy, supported by recent meta-analyses confirming the positive impact of professional development on self-efficacy (Wang & Liu, 2022). Teaching efficacy also did not vary significantly with age, academic background, qualification, or experience, aligning with the findings of Shazadi et al. (2011) and Shohani et al. (2014), and supporting the notion that equitable access to training and adherence to professional standards can reduce disparities in efficacy (Torres & Almeida, 2021).

Regression analysis revealed that epistemological beliefs significantly predicted teaching efficacy, explaining 24% of its variance. This supports earlier studies (Chrysostomou & Philippou, 2010; Ekinci, 2017; Tezci et al., 2016) and recent research highlighting the role of epistemological reflection in teacher confidence (Martinez & Flores, 2024). Although the predictive power is moderate, enhancing epistemological beliefs may effectively boost teaching efficacy.

Theoretically, teachers' fallibilist views align with Perry's (1997) relativism stage, which values context-dependent knowledge and multiple solutions. Belenky et al.'s (1986) model suggests that these teachers engage in constructed and connected knowing, viewing knowledge as both subjective and objective. The Reflective Judgment Model (King & Kitchener, 2002) situates them at a reflective stage of knowledge construction. Kuhn's theory classifies their epistemology as multiplist and evolutionist, consistent with fallibilism. Mogolda's (1992) epistemological reflection further supports the view that teachers value students' perspectives as legitimate sources of knowledge. Recent cognitive and social epistemology research also emphasizes this multidimensional, relational conception of knowledge among educators (Rogers & Hall, 2023).

Teaching efficacy, particularly instructional efficacy, was high, consistent with Bandura's (1997) self-efficacy theory, which links training and successful performance to efficacy. No age-related differences were detected, contrary to predictions from cognitive development theory (Bayley & Oden, 1955). This suggests that professional experience and training may mitigate developmental differences, as supported by recent longitudinal studies (Chen & Zhao, 2023). Overall, teachers perceive mathematical knowledge as correctable and contextually justified, endorsing multiple learning approaches with an emphasis on adopting the most effective methods that reflect current pedagogical paradigms, which advocate for flexibility and reflective practice (Johnson & Kim, 2024).

Conclusion and Implications

The mathematics teachers at the secondary level have strong confidence in mathematical knowledge and the knowledge acquisition system. Mathematics teachers of that level believe that mathematics is subjective, contextual, and it is a human creation, and its truth is also subjective. Collaboration and contextual activities promote the learning of mathematics. The major biological and educational factors related to mathematics teachers have not played a significant role in shaping the epistemological beliefs and teaching efficacy of mathematics. The professional and educational backgrounds do not significantly influence the epistemological beliefs and teaching efficacy of trained mathematics teachers. Except for the minimum qualification, the additional qualification does not have a significant role in epistemological belief and teaching efficacy. Mathematics teachers with better epistemological beliefs tend to have more effective teaching skills in mathematics.

The findings suggest that teacher preparation institutions should foster the development of mathematics teachers' epistemological beliefs, particularly fallibilist perspectives, to enhance their teaching effectiveness. Training programs should extend beyond the functional and content aspects of pedagogy by incorporating cognitive and affective dimensions. Without addressing these deeper components, training alone may not be sufficient to improve teaching efficacy. Due to the limited number of female participants, this study did not analyze the data from a gender perspective.

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