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Using SEM-PLS to examine the correlation between habit of mind and belief of mathematics pre- service students

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Abstract: Mathematical belief, encompassing cognitive, affective, and dispositional aspects, fundamentally shapes individuals' attitudes toward mathematics. It reflects seriousness, confidence, and subjective stances in mathematical thinking and learning. In teacher education, prospective teachers' beliefs significantly influence their instructional choices and student achievement. This study investigates the direct effect of Habit of Mind on mathematical belief using second-order confirmatory factor analysis within a Structural Equation Modeling (SEM) framework. Data from 200 prospective mathematics teachers were collected via a cross-sectional survey. Results indicate a strong, positive impact of Habit of Mind on mathematical belief. Importance-Performance Map Analysis (IPMA) further suggests that fostering consistent, reflective thinking habits enhances mathematical beliefs. Among Habit of Mind dimensions, Applying Past Knowledge to New Situations, Metacognition, and Thinking Interdependently emerged as the most influential. These cognitive dispositions can be systematically developed through well-designed instructional strategies in university settings. The study highlights the necessity of integrating Habit of Mind development into teacher education programs to strengthen mathematical beliefs and support more effective mathematics teaching and learning.
Keywords: *Beliefs, Habit of mind, Mathematics, Preservice students, SEM-PLS.*

1. Introduction

The primary objective of education is to cultivate high-quality human resources—individuals who are adaptable, progressive, and competitive within their respective fields of expertise [1, 2]. These competencies are expected to enhance a nation's competitiveness, enabling it to thrive amid globalization across various sectors [3]. Accordingly, higher education should not only focus on the transmission of scientific knowledge but also promote character development by integrating cognitive, affective, and psychomotor domains [4]. Within the affective domain, belief in mathematics is one aspect that warrants particular attention.

Beliefs function as a driving force behind actions, representing an internal commitment to behavior. They play a critical role in eliminating doubts that may hinder engagement and in fostering the development of decisive actions [5]. In the context of mathematics learning, students' beliefs refer to the attitudes they exhibit during their coursework [6]. Academic success in mathematics is influenced not only by students' skills and abilities but also by their confidence, which significantly contributes to their performance [7].

Beliefs are a key determinant of students' success in learning mathematics [8]. Students who engage seriously in mathematics by completing assignments diligently, participating actively in discussions, and submitting work thoroughly and on time demonstrate strong mathematical confidence. Positive beliefs increase students' willingness to engage meaningfully with mathematical concepts, while negative beliefs can hinder their learning outcomes. Beliefs also bridge the gap between teachers' knowledge and classroom practice [9] and are considered strong predictors of decision-making

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throughout life. Belief systems develop over time and are shaped by cultural contexts, mathematics classroom experiences, teaching methods, and personal reflection. According to Lau [10] there are three interconnected components of teachers' mathematical belief systems: their view of the nature of mathematics, their model of teaching mathematics, and their conception of how mathematics is learned. For instance, a teacher who views mathematics as a problem-solving discipline is more likely to encourage student exploration and conceptual understanding, while one with an instrumentalist view may emphasize rote memorization and procedural fluency [11].

Research has demonstrated that changes in teachers' beliefs, knowledge, and practices occur gradually over time [12]. As a result, fostering a positive classroom environment is essential to promoting favorable attitudes toward mathematics. Whether through classroom activities, homework, practice, or assessments, it is vital to support and encourage students in completing tasks so they remain motivated, confident in their mathematical abilities, and engaged in problem-solving processes [13]. Students' mathematics learning is also shaped by internal factors, including attitudes, beliefs, motivation, self-confidence, and anxiety [14].

Classroom-based mathematics instruction gradually influences students' mathematical beliefs, which in turn affect how they engage with and comprehend course material. Low mathematical belief can result in reduced participation in learning, a limited understanding of mathematical structures, and difficulty applying mathematical knowledge in everyday contexts [15]. Moreover, students with low mathematical belief often lack confidence when solving mathematical problems. Teachers play a pivotal role in shaping students' attitudes and behaviors, thereby significantly impacting learning outcomes [16]. They must contribute actively to the development of students' mathematical understanding by providing opportunities for intellectual challenge and engagement in higher-order thinking through the purposeful selection of effective teaching strategies and tasks [17].

Mathematics education seeks to cultivate cognitive dispositions that support effective problem-solving in both academic and real-life contexts [18]. Habits of Mind—defined as tendencies toward intelligent behavior play a vital role in mathematical problem-solving and substantially influence pre-service teachers' mathematical beliefs [19]. Investigating the relationship between Habits of Mind and mathematical beliefs among pre-service teachers is therefore essential, as these factors can significantly shape their future teaching practices and influence students' learning experiences. It is well recognized that student success is greatly influenced by habitual behaviors. When practiced consistently, positive habits can cultivate productive skills. A habit may be defined as a learned pattern of responding to specific situations, repeated consistently over time [20]. Meanwhile, Habits of Mind refer to intelligent behaviors applied when encountering problems that do not have immediately obvious solutions [21]. This includes processes by which students construct their own understanding and act constructively in the face of dilemmas, uncertainty, or complexity. As such, cultivating Habits of Mind can enhance mathematical thinking and reinforce positive mathematical beliefs.

Habits of Mind are characterized by the behaviors of effective problem solvers when faced with dilemmas, paradoxes, and complex problems without clear solutions [22]. Pre-service teachers' beliefs about mathematics encompass their personal philosophies, attitudes, and values related to the nature of mathematics as well as its teaching and learning. These beliefs may vary widely between individuals and even within the same individual depending on context. Beliefs about mathematics may range from viewing it as a static body of knowledge to perceiving it as a dynamic and evolving field of inquiry [23]. A growth mindset as opposed to a fixed mindset encourages greater effort, resilience, and persistence in the face of academic challenges, ultimately leading to improved academic performance [24]. Mathematical beliefs are shaped by value judgments formed through individuals' past experiences with mathematics [25]. These subjective beliefs significantly influence students' strategies and behaviors in mathematical problem-solving [26]. Furthermore, beliefs are closely intertwined with both affective and cognitive domains in mathematics education [27]. Therefore, exploring the interconnections between beliefs and related constructs can offer deeper insights into how mathematics is learned and taught [10].

2. Method

This research employed a cross-sectional design, providing a snapshot of the variables of interest at a single point in time. Such a design facilitates the examination of relationships between variables without manipulation [28]. A quantitative approach was utilized to identify and measure the strength and direction of the correlation between Habits of Mind and beliefs about mathematics among pre-service teachers. The unit of analysis was the individual, with participants completing a questionnaire consisting of sorted choices and statements. Research variables were measured perceptually using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

The independent variable, Habits of Mind, was assessed through seven indicators: persisting (PS), managing impulsivity (MI), thinking flexibly (TF), metacognition (MC), applying past knowledge (APKN), remaining open to continuous learning (ROCL), and thinking interdependently (TI). The dependent variable, beliefs about mathematics, was measured using five indicators: certainty of knowledge (CK), role of the lecturer (RL), systematic process (SP), innate ability (IA), and quick learning (QL).

A total of 200 responses were collected from mathematics education students during the 2022–2023 academic year. Respondents were drawn from five cohorts: Batch 1 included 42 students (37 women, 5 men); Batch 2 had 23 students (19 women, 4 men); Batch 3 comprised 37 students (31 women, 6 men); Batch 4 consisted of 89 students (77 women, 12 men); and Batch 5 had 9 students (8 women, 1 man). The distribution of respondents is illustrated in Figure 1.

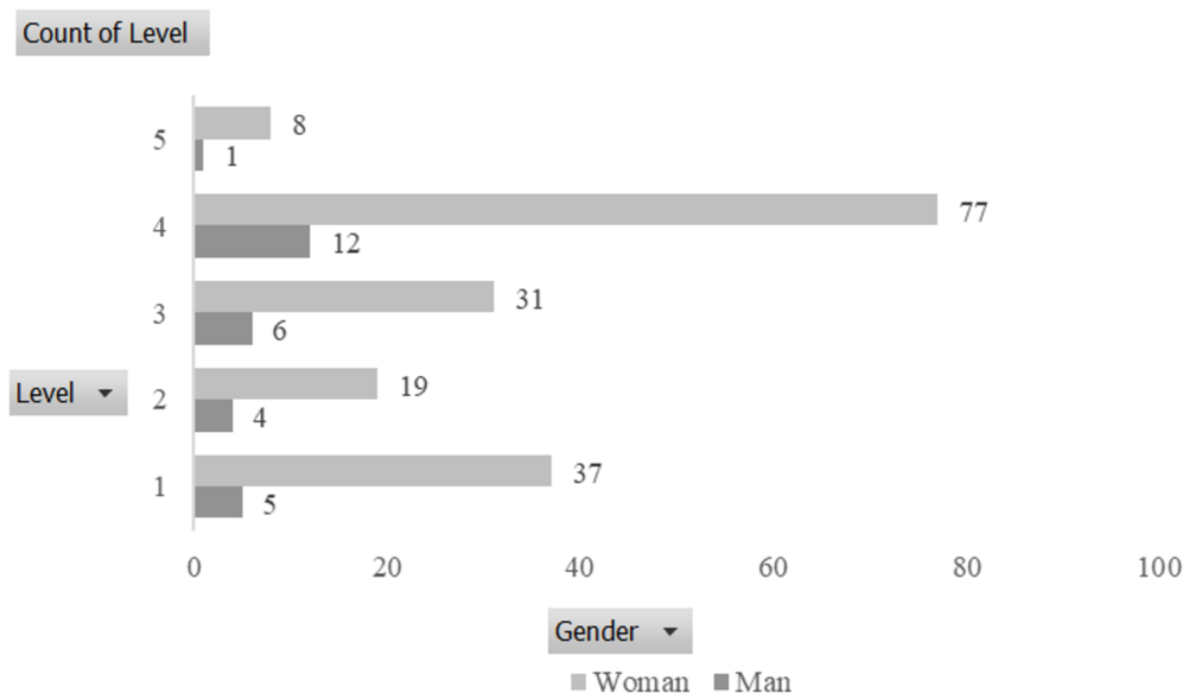

Figure 1.
Sample size.

Data analysis for hypothesis testing in this study was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM offers a robust statistical approach for examining complex relationships between latent variables, especially when handling non-normal data and exploratory research questions. This method is particularly suitable for investigating the correlation between Habits of Mind and beliefs about mathematics among pre-service students [29]. It enables the assessment of both direct and indirect effects, providing insights into the mechanisms through which

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Habits of Mind may influence beliefs about mathematics. Prior to hypothesis testing, the relationships between the latent variables, namely Habits of Mind and beliefs about mathematics, were first examined using SmartPLS software.

3. Results and Discussion

This research was conducted using a quantitative approach, employing descriptive statistics and hypothesis testing with Partial Least Squares Structural Equation Modeling (PLS-SEM). The variables involved in this study were Habits of Mind and Beliefs about Mathematics. Data were collected from 200 prospective teacher students and are presented descriptively in Table 1.

Table 1.
Descriptive, Normality statistics.

Construct	Item Code	Mean	Main	Max	St. Deviation	Excess kurtosis	Skewness
Persisting (PS)	PS 1	4.297	3	5	0.524	-0.623	0.180
	PS 2	4.267	3	5	0.551	-0.442	0.027
	PS 3	3.823	3	5	0.716	-1.025	0.276
	PS 4	3.949	3	5	0.585	-0.086	0.008
	PS 5	3.838	3	5	0.665	-0.768	0.195
	PS 6	4.201	3	5	0.609	-0.485	-0.137
	PS 7	3.712	3	5	0.711	-0.926	0.483
	PS 8	3.607	3	5	0.679	-0.655	0.679
Managing Impulsivity (MI)	MI 1	4.066	3	5	0.581	-0.061	-0.006
	MI 2	4.069	3	5	0.614	-0.357	-0.040
	MI 3	3.664	3	5	0.694	-0.806	0.564
	MI 4	3.904	3	5	0.712	-1.023	0.142
	MI 5	4.195	3	5	0.538	-0.049	0.119
	MI 6	4.252	3	5	0.592	-0.503	-0.141
Thinking Fexibly (TF)	TF 1	3.997	3	5	0.729	-1.117	0.005
	TF 2	4.366	3	5	0.557	-0.797	-0.138
	TF 3	4.045	3	5	0.538	0.451	0.038
	TF 4	3.718	3	5	0.647	-0.718	0.352
	TF 5	4.009	3	5	0.582	-0.036	-0.001
	TF 6	3.835	3	5	0.731	-1.099	0.268
	TF 7	3.763	3	5	0.616	-0.571	0.198
	TF 8	3.787	3	5	0.564	-0.271	-0.001
Metacognition (MC)	MC 1	4.048	3	5	0.583	-0.061	-0.005
	MC 2	4.192	3	5	0.542	-0.059	0.101
	MC 3	3.919	3	5	0.749	-1.210	0.134
	MC 4	3.868	3	5	0.591	-0.242	0.041
	MC 5	3.958	3	5	0.557	0.221	-0.016
	MC 6	3.991	3	5	0.582	-0.036	0.001
	MC 7	4.021	3	5	0.566	0.132	0.004
	MC 8	4.042	3	5	0.557	0.221	0.016
	MC 9	3.571	3	5	0.624	-0.557	0.625
Applying Past Knowledge to New Situations (APKN)	APKN 1	4.108	3	5	0.514	0.576	0.155
	APKN 2	3.889	3	5	0.660	-0.717	0.124
	APKN 3	3.532	3	5	0.651	-0.383	0.836
	APKN 4	4.150	3	5	0.498	0.531	0.287
	APKN 5	4.216	3	5	0.515	-0.057	0.248
	APKN 6	3.886	3	5	0.638	-0.577	0.104
	APKN 7	4.207	3	5	0.533	-0.085	0.143

Construct	Item Code	Mean	Main	Max	St. Deviation	Excess kurtosis	Skewness
	APKN 8	4.264	3	5	0.522	-0.405	0.210
	APKN 9	3.910	3	5	0.770	-1.300	0.156
Remaining Open to Continous Learning (ROCL)	ROCL 1	3.961	3	5	0.686	-0.868	0.050
	ROCL 2	3.847	3	5	0.746	-1.171	0.257
	ROCL 3	4.006	3	5	0.763	-1.285	-0.010
	ROCL 4	4.381	3	5	0.560	-0.812	-0.190
	ROCL 5	4.060	3	5	0.602	-0.251	-0.025
	ROCL 6	3.634	3	5	0.661	-0.686	0.566
Thinking Interdependently (TI)	TI 1	3.598	3	5	0.693	-0.652	0.733
	TI 2	3.730	3	5	0.710	-0.941	0.443
	TI 3	4.024	3	5	0.547	0.352	0.015
	TI 4	4.138	3	5	0.519	0.389	0.172
	TI 5	3.817	3	5	0.755	-1.192	0.318
	TI 6	4.267	3	5	0.573	-0.483	-0.079
	TI 7	3.757	3	5	0.758	-1.147	0.439
	TI 8	3.820	3	5	0.746	-1.156	0.306
Certainty of Knowledge (CK)	CK 1	3.736	3	5	0.765	-1.142	0.489
	CK 2	4.300	3	5	0.559	-0.580	-0.046
	CK 3	4.132	3	5	0.616	-0.431	-0.088
	CK 4	3.778	3	5	0.742	-1.110	0.383
	CK 5	4.270	3	5	0.594	-0.547	-0.172
	CK 6	3.667	3	5	0.710	-0.855	0.584
	CK 7	4.207	3	5	0.582	-0.348	-0.062
	CK 8	4.060	3	5	0.602	-0.251	-0.025
	CK 9	3.625	3	5	0.719	-0.782	0.702
	CK 10	4.120	3	5	0.608	-0.362	-0.067
Quick Learning (QL)	QL 1	3.634	3	5	0.713	-0.792	0.669
	QL 2	3.544	3	5	0.668	-0.431	0.842
	QL 3	3.949	3	5	0.639	-0.553	0.045
	QL 4	3.745	3	5	0.746	-1.089	0.454
Systematic Process (SP)	SP 1	4.204	3	5	0.591	-0.388	-0.087
	SP 2	4.237	3	5	0.560	-0.340	0.006
	SP 3	4.177	3	5	0.571	-0.198	-0.009
	SP 4	3.958	3	5	0.638	-0.537	0.036
	SP 5	4.321	3	5	0.597	-0.634	-0.261
	SP 6	3.898	3	5	0.668	-0.767	0.120
	SP 7	3.733	3	5	0.696	-0.894	0.417
	SP 8	3.799	3	5	0.726	-1.059	0.328
	SP 9	3.871	3	5	0.696	-0.936	0.181
	SP 10	4.009	3	5	0.761	-1.275	-0.015
	SP 11	4.201	3	5	0.558	-0.193	0.031
	SP 12	3.820	3	5	0.691	-0.909	0.256
	SP 13	4.336	3	5	0.560	-0.701	-0.102
	SP 14	3.901	3	5	0.801	-1.424	0.181
Innate Ability (IA)	IA 1	3.664	3	5	0.658	-0.722	0.489
	IA 2	4.027	3	5	0.607	-0.278	-0.013
	IA 3	3.625	3	5	0.723	-0.793	0.708
	IA 4	3.682	3	5	0.756	-1.020	0.604
Role of Lecturer (RL)	RL 1	4.150	3	5	0.576	-0.163	-0.014
	RL 2	3.562	3	5	0.644	-0.506	0.719
	RL 3	3.883	3	5	0.659	-0.713	0.130

Construct	Item Code	Mean	Main	Max	St. Deviation	Excess kurtosis	Skewness
	RL 4	4.102	3	5	0.560	0.090	0.028
	RL 5	3.916	3	5	0.705	-0.986	0.120
	RL 6	4.261	3	5	0.586	-0.502	-0.128
	RL 7	4.138	3	5	0.624	-0.497	-0.107
	RL 8	3.793	3	5	0.617	-0.536	0.164
	RL 9	3.709	3	5	0.729	-0.980	0.512
	RL 10	3.691	3	5	0.704	-0.877	0.519
	RL 11	4.048	3	5	0.562	0.159	0.013
	RL 12	3.850	3	5	0.640	-0.615	0.145
	RL 13	3.910	3	5	0.678	-0.830	0.113
	RL 14	4.057	3	5	0.595	-0.183	-0.018
	RL 15	3.547	3	5	0.668	-0.444	0.831
	RL 16	3.483	3	5	0.642	-0.129	0.986

Table 1 presents the descriptive statistical results for the components of Habits of Mind and Beliefs about Mathematics. Habits of Mind are described by seven constructs, with the highest average observed in Managing Impulsivity (MI) at 4.03, which pertains to the ability to manage time effectively and think before acting. The lowest average was found in Thinking Interdependently (TI) at 3.89, reflecting the capacity to collaborate and learn with others in a team setting. Regarding Beliefs about Mathematics, the highest average was 4.03 in Systematic Process (SP), indicating that classroom learning follows a sequential order aligned with students' cognitive development. The lowest construct was Quick Learning (QL), with an average of 3.72. Moreover, the skewness values ranging between -2 and 2 suggest that the research data originate from a normally distributed population [30]. Structural model assessment included evaluating path coefficients and their significance levels, representing the direct effects between variables [31]. Convergent and discriminant validity tests using SEM-PLS were performed on each instrument item for Habits of Mind and Beliefs about Mathematics to confirm the validity and reliability of the measures [32].

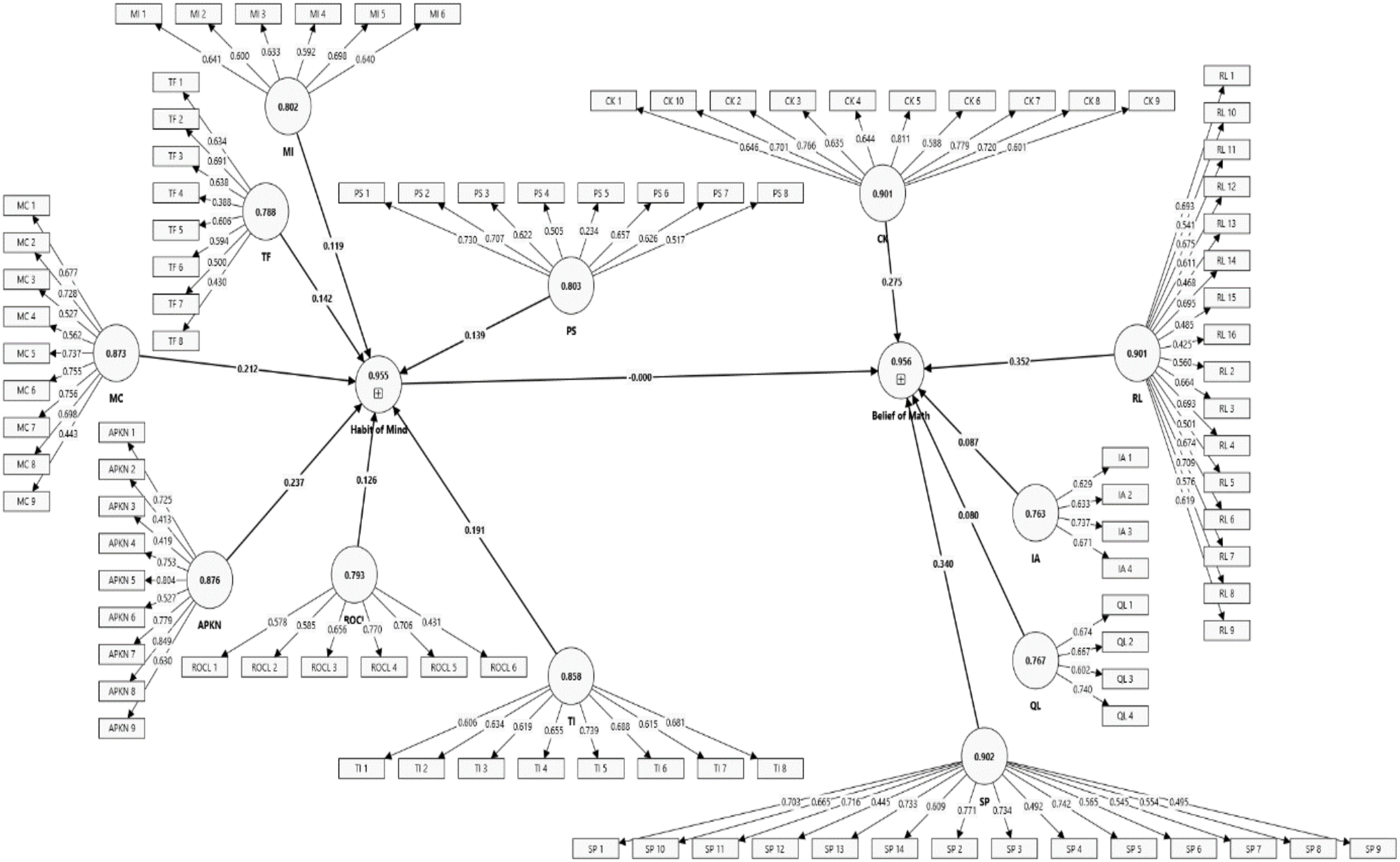

Figure 2.
Initial PLS Research Model.

Table 2.
First Order Construct.

Construct	Item Code	Outer Loading	Composite Reliability	Average Variance Extracted (AVE)
PS	PS 1	0.817	0.850	0.591
	PS 2	0.846		
	PS 4	0.581		
	PS 6	0.802		
MI	MI 1	0.688	0.751	0.389
	MI 3	0.426		
	MI 4	0.444		
	MI 5	0.761		
	MI 6	0.718		
TF	TF 1	0.507	0.771	0.364
	TF 2	0.699		
	TF 3	0.678		
	TF 5	0.643		
	TF 6	0.541		
	TF 7	0.522		
MC	MC 1	0.663	0.905	0.615
	MC 2	0.801		
	MC 5	0.749		
	MC 6	0.824		
	MC 7	0.846		
	MC 8	0.809		
APKN	APKN 1	0.793	0.903	0.617
	APKN 4	0.829		
	APKN 5	0.880		
	APKN 7	0.827		
	APKN 8	0.867		
	APKN 9	0.420		
ROCL	ROCL 1	0.427	0.761	0.401
	ROCL 2	0.502		
	ROCL 3	0.597		
	ROCL 4	0.802		
	ROCL 5	0.757		
TI	TI 1	0.617	0.836	0.392
	TI 2	0.510		
	TI 3	0.556		
	TI 4	0.734		
	TI 5	0.602		
	TI 6	0.724		
	TI 7	0.573		
	TI 8	0.658		
CK	CK 1	0.425	0.885	0.504
	CK 10	0.771		
	CK 2	0.744		
	CK 3	0.700		
	CK 4	0.425		
	CK 5	0.852		
	CK 7	0.846		

	CK 8	0.768		
QL	QL 1	0.821	0.766	0.540
	QL 2	0.870		
	QL 4	0.434		
SP	SP 1	0.777	0.899	0.563
	SP 11	0.681		
	SP 13	0.748		
	SP 2	0.849		
	SP 3	0.778		
	SP 5	0.778		
	SP 6	0.617		
IA	IA 2	0.875	0.695	0.543
	IA 3	0.567		
RL	RL 1	0.755	0.893	0.460
	RL 11	0.634		
	RL 12	0.620		
	RL 14	0.748		
	RL 2	0.432		
	RL 3	0.687		
	RL 4	0.736		
	RL 6	0.736		
	RL 7	0.762		
	RL 8	0.600		

Figure 2 and Table 2 present the results of construct validity testing based on the items within each variable. These confirmatory results aim to verify and assess the relationships between each item and their corresponding indicators in the Habits of Mind and Beliefs about Mathematics variables. Accordingly, a consistent Partial Least Squares (PLS) approach was employed. Construct validity ensures that a set of measurable variables accurately represents the intended construct [33]. Indicators of construct validity typically include convergent validity, composite reliability (CR), and discriminant validity. The results of the convergent validity and CR assessments are shown in Table 2. This analysis reveals that each item's loading factor is ≥ 0.40, composite reliability is ≥ 0.70, average variance extracted (AVE) values exceed 0.50, and CR values surpass 0.70. Therefore, the convergent validity and composite reliability of the constructs are deemed satisfactory.

Table 3.
Second Order Construct.

Construct	Code	Outer Loading	Composite Reliability	Average Variance Extracted (AVE)
Habit of Mind	PS	0.612	0.908	0.589
	MI	0.649		
	TF	0.739		
	MC	0.842		
	APKN	0.906		
	ROCL	0.744		
	TI	0.833		
Belief of Math	CK	0.903	0.870	0.587
	QL	0.435		
	SP	0.842		
	IA	0.644		
	RL	0.898		

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In Table 3, the variable Habit of Mind is measured by seven constructs, while the variable Belief about Mathematics is measured by five constructs. These constructs are valid, as indicated by outer loading values ranging from 0.435 to 0.903, demonstrating strong correlations between the measurement items and their respective variables. The reliability of the Habit of Mind variable is acceptable, with a composite reliability (CR) of 0.908, exceeding the threshold of 0.70, and convergent validity supported by an average variance extracted (AVE) of 0.589, which is greater than 0.50. Similarly, the Belief about Mathematics variable demonstrates acceptable reliability with a composite reliability of 0.870 and convergent validity with an AVE of 0.587.

Among the seven valid measurement items for Habit of Mind, the strongest indicators are Applying Past Knowledge to New Situations (APKN = 0.906) and Metacognition (MC = 0.842). Applying past knowledge in mathematics teaching has been shown to positively influence students' achievement [34]. This effect is attributed to increased student interest and the recognition that mathematics is a dynamic field that has evolved and continues to evolve. Identifying specific aspects of prior mathematical knowledge that effectively enhance student learning outcomes is crucial. Among the five valid measurement items for Belief about Mathematics, the strongest indicators are Certainty of Knowledge (CK = 0.903) and Role of Lecturer (RL = 0.898).

Table 4.
Fornell Larcker Criterion.

	CK	QL	SP	IA	RL	PS	MI	TF	MC	APKN	ROCL	TI
CK	**0.785**											
QL	0.346	**1.000**										
SP	0.623	0.357	**0.801**									
IA	0.599	0.133	0.408	**1.000**								
RL	0.721	0.350	0.683	0.559	**0.779**							
PS	0.455	0.261	0.482	0.304	0.445	**0.879**						
MI	0.517	0.190	0.489	0.342	0.472	0.510	**0.836**					
TF	0.597	0.284	0.528	0.439	0.548	0.406	0.500	**0.833**				
MC	0.642	0.259	0.448	0.475	0.596	0.377	0.463	0.575	**0.796**			
APKN	0.747	0.346	0.618	0.553	0.710	0.450	0.506	0.625	0.697	**0.840**		
ROCL	0.566	0.276	0.525	0.382	0.511	0.475	0.492	0.509	0.529	0.593	**0.861**	
TI	0.665	0.353	0.518	0.537	0.620	0.486	0.402	0.530	0.626	0.716	0.618	**0.863**

Table 4 presents the Fornell-Larcker criterion, which is used to assess discriminant validity. Discriminant validity ensures that constructs are theoretically distinct and empirically verified through statistical testing. According to the Fornell and Larcker criterion, the square root of the average variance extracted (AVE) for each construct should be greater than its correlations with other constructs [35]. As shown in Table 4, the square root of the AVE for all constructs exceeds their correlations with other variables. For example, the square root of the AVE for Certainty of Knowledge (CK) is 0.785, which is higher than its correlations with all other constructs. Since the square roots of the AVE values for all latent variables are greater than their correlations with other constructs, the discriminant validity requirements for this model have been satisfied.

Table 5.
Path Analysis.

Hypothesis	Path	Std. Beta	Std. Error	T-Value	P-Value	Confident Interval		Decision
						5.0%	95.0%	
H1	Habit -> Belief	0.837	0.032	26.081	0.000	0.781	0.889	Supported

The findings of this study provide compelling empirical support for the first hypothesis (H1), which posits that Habits of Mind (HoM) significantly influence the enhancement of mathematical beliefs among pre-service teachers. The statistical analysis revealed a robust and statistically significant

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positive correlation between the two constructs, as evidenced by a path coefficient of 0.837 and a p-value of 0.000 ($p < 0.05$). These results underscore that fostering the development of Habits of Mind in teacher preparation programs is not only beneficial but essential for nurturing constructive beliefs about mathematics. Within the field of mathematics education, this correlation holds significant implications, particularly given the well-documented role that teacher beliefs play in shaping pedagogical decisions, instructional approaches, and students' learning outcomes.

This study sought to examine the nuanced relationship between cognitive dispositions manifested through Habits of Mind and affective constructs such as beliefs about mathematics. One of the key contributions of this research lies in its demonstration that HoM are not merely abstract cognitive tendencies, but practical, cultivable habits that significantly shape how future educators conceptualize, engage with, and ultimately teach mathematics. The idea that thinking dispositions impact mathematical belief systems is increasingly being recognized in the literature, with researchers such as Sabanal, et al. [36] highlighting that teachers who view mathematics as an essential tool for professional and personal development are more inclined to exhibit adaptive instructional behaviors rooted in positive mathematical beliefs.

Consistent with the findings of Hawash, et al. [37] the current study affirms that individuals who possess well-developed HoM such as persistence, managing impulsivity, striving for accuracy, and metacognitive awareness tend to hold more sophisticated and growth-oriented beliefs about mathematics. These beliefs include seeing mathematics as a subject that is logical, creative, and learnable by all students. Such beliefs contrast sharply with fixed, procedural views that regard mathematics as static and reserved for the intellectually elite. Beliefs of this nature significantly impact how pre-service teachers approach mathematical content and their expectations for students' engagement, ability, and achievement.

Further analysis of specific Habits of Mind revealed that Applying Past Knowledge to New Situations (APKN), Metacognition (MC), and Thinking Interdependently (TI) were the most influential in fostering mathematical beliefs. Each of these sub-constructs contributes to different dimensions of mathematical belief development. APKN enables future educators to transfer their learning across contexts, promoting a belief in the coherence and transferability of mathematical knowledge. Metacognition fosters reflective thinking, which is critical for evaluating one's understanding, adjusting teaching strategies, and reinforcing the belief that mathematics involves reasoning and insight, not just memorization. Thinking interdependently underscores the social nature of mathematical knowledge construction and promotes beliefs that value communication, collaboration, and collective problem-solving.

A critical implication of these findings concerns the opportunity for intervention in teacher education. Prior research has consistently shown that beliefs about mathematics are formed early and often remain unchanged throughout a teacher's career [38]. However, this study challenges the notion that such beliefs are immutable. When prospective teachers are exposed to structured activities that foster reflective thinking, critical inquiry, and collaborative exploration hallmarks of HoM they begin to reconstruct previously held beliefs. Consequently, the integration of HoM principles into coursework, practicum, and professional learning communities may serve as a lever for transformative belief change. Additionally, the study reinforces the link between Habits of Mind, belief systems, and self-efficacy. As Lau [10] assert, mathematical self-efficacy a teacher's belief in their ability to teach mathematics effectively has a direct bearing on student achievement. The present findings suggest that cultivating HoM can serve as a means to strengthen self-efficacy beliefs. When teachers believe in their capacity to solve mathematical problems and to teach them meaningfully, they are more likely to embrace complex tasks, implement student-centered strategies, and provide the kind of persistence-driven instruction that leads to deeper learning.

Belief systems also influence classroom climate and pedagogical practices. Gullo, et al. [39] report that early-career teachers who possess adaptive beliefs about mathematics tend to implement mastery-oriented instructional strategies and provide emotional support to students. This study contributes to

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this discussion by showing that HoM such as persistence and metacognition not only shape beliefs but also promote instructional behaviors that foster inclusive and supportive learning environments. Teachers with strong HoM are more likely to see student mistakes as opportunities for learning rather than signs of failure an attitude that translates into the creation of classrooms where risk-taking is encouraged and errors are treated as part of the mathematical process. This connection also aligns with the growing body of literature on teacher leadership and professional identity. Bosica, et al. [40] found that pre-service teachers who are exposed to leadership development programs that emphasize reflective inquiry, critical thinking, and peer collaboration are more likely to develop strong instructional identities. The current study extends this by demonstrating that HoM not only promote leadership dispositions but also cultivate a belief in the importance, relevance, and accessibility of mathematics. This belief can empower teachers to become change agents in their schools—leading initiatives that promote mathematical thinking across disciplines and fostering a culture of inquiry. Another noteworthy implication relates to the relationship between teacher beliefs and classroom management. According to Cohen and Katz [41] teachers who possess strong self-efficacy rooted in robust beliefs and cognitive habits tend to manage classrooms more effectively and employ strategies that maximize engagement. Similarly, Wettstein, et al. [42] found that self-efficacious teachers are more adaptable, empathetic, and student-centered. In this light, HoM function as both cognitive and emotional regulators that empower teachers to respond effectively to the complex, evolving demands of classroom teaching.

Despite these encouraging findings, the study also points to areas where further research is warranted. One such area is the specific role of teacher leadership and mentoring programs in reinforcing Habits of Mind and belief development. Although Warren [43] posits that such programs have the potential to foster sustained professional growth, their direct impact on mathematics instruction and belief systems remains underexplored. Future research might investigate how leadership programs that emphasize reflective practice and collaborative problem-solving can be leveraged to promote both HoM and adaptive mathematical beliefs.

The role of mentorship is similarly critical. Alegado and Soe [44] emphasize that mentorship during the early stages of a teacher's career provides the emotional and intellectual scaffolding necessary for the development and reinforcement of positive instructional beliefs. In the context of this study, mentorship that models and encourages the use of HoM can serve as a catalyst for belief transformation. Structured mentoring that includes opportunities for dialogue, reflection, and co-teaching can help pre-service teachers internalize both the habits and the beliefs that underpin effective mathematics instruction.

In conclusion, the present study makes a significant contribution to the discourse on mathematics teacher education by demonstrating a strong and meaningful correlation between Habit of Mind and beliefs about mathematics among pre-service teachers. These findings have far-reaching implications for how teacher preparation programs are conceptualized and implemented. Programs that aim to produce reflective, resilient, and relational mathematics educators must go beyond content delivery and actively cultivate the habits of thinking that shape how future teachers believe, teach, and lead. By embedding Habit of Mind into curriculum design, field experiences, and mentoring structures, institutions can empower the next generation of educators to see mathematics as a dynamic, creative, and empowering discipline—one that they can teach with confidence and conviction.

4. Conclusion

The findings of this study indicate a positive correlation between Habits of Mind and beliefs about mathematics among prospective teachers. Specifically, students who exhibit strong cognitive habits tend to demonstrate higher confidence in their mathematical abilities. This suggests that fostering thinking habits, such as persistence, metacognition, and applying past knowledge to new situations, can be effectively facilitated through teacher education programs that prioritize the development of prospective teachers' competencies. Moreover, strengthening these cognitive dispositions not only enhances mathematical self-efficacy but also contributes to more adaptive and constructive beliefs about mathematics, which are critical for effective teaching. Consequently, teacher preparation institutions should intentionally integrate Habit of Mind cultivation within their curricula and practicum experiences to empower future educators to foster positive mathematical beliefs in themselves and their students. Ultimately, this approach can promote more resilient, reflective, and capable mathematics teachers, positively impacting student learning outcomes.

Transparency:
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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References

[1] I. Gligorea, M. Cioca, R. Oancea, A.-T. Gorski, H. Gorski, and P. Tudorache, "Adaptive learning using artificial intelligence in e-learning: A literature review," *Education Sciences*, vol. 13, no. 12, p. 1216, 2023. https://doi.org/10.3390/educsci13121216

[2] L. Hetmanenko, "The role of interactive learning in mathematics education: Fostering student engagement and interest," *Multidisciplinary Science Journal*, vol. 6, pp. 100–110, 2024.

[3] A. Chronaki and A. Yolcu, "Mathematics for "citizenship" and its "other" in a "global" world: Critical issues on mathematics education, globalisation and local communities," *Research in Mathematics Education*, vol. 23, no. 3, pp. 241-247, 2021. https://doi.org/10.1080/14794802.2021.1995780

[4] Y. Nakakoji and R. Wilson, "Interdisciplinary learning in mathematics and science: Transfer of learning for 21st century problem solving at university," *Journal of Intelligence*, vol. 8, no. 3, p. 32, 2020. https://doi.org/10.3390/jintelligence8030032

[5] S. Schukajlow, K. Rakoczy, and R. Pekrun, "Emotions and motivation in mathematics education: Where we are today and where we need to go," *ZDM–Mathematics Education*, vol. 55, no. 2, pp. 249-267, 2023.

[6] S. Lerman, *Encyclopedia of mathematics education*. Switzerland: Springer, 2020.

[7] P. Pramulia, V. Yustitia, D. Kusmaharti, A. M. Fanny, and I. A. Oktavia, "Ethnomathematics of Al Akbar Mosque Surabaya: Augmented reality comics to improve elementary school students' literacy and numeracy," *Multidisciplinary Science Journal*, vol. 7, no. 6, p. 2025277, 2025.

[8] J. Segarra and C. Julià, "Mathematics teaching efficacy belief and attitude of pre-service teachers and academic achievement," *European Journal of Science and Mathematics Education*, vol. 10, no. 1, pp. 1-14, 2022.

[9] J. Hoth, M. Larrain, and G. Kaiser, "Identifying and dealing with student errors in the mathematics classroom: Cognitive and motivational requirements," *Frontiers in psychology*, vol. 13, pp. 1–16, 2022.

[10] W. W. Lau, "Predicting pre-service mathematics teachers' teaching and learning conceptions: The role of mathematical beliefs, mathematics self-efficacy, and mathematics teaching efficacy," *International Journal of Science and Mathematics Education*, vol. 20, no. 6, pp. 1141-1160, 2022.

[11] M. F. Machaba, T. J. Age, and P. E. Rankweteke, "Mathematics student teachers' external supervisors' beliefs about mathematics: ODeL environment in focus," *Journal of Advanced Sciences and Mathematics Education*, vol. 4, no. 2, pp. 81-94, 2024.

[12] P. Portaankorva-Koivisto, A. Laine, and M. Ahtee, "Two primary teachers developing their teaching problem-solving during three-year in-service training," *International Electronic Journal of Mathematics Education*, vol. 16, no. 1, p. em0624, 2021.

[13] R. Wakhata, S. Balimuttajjo, and V. Mutarutinya, "Relationship between students' attitude towards, and performance in mathematics word problems," *Plos One*, vol. 19, no. 2, p. e0278593, 2024. https://doi.org/10.1371/journal.pone.0278593

[14] A. Twohill, S. NicMhuirí, L. Harbison, and A. Karakolidis, "Primary preservice teachers' mathematics teaching efficacy beliefs: The role played by mathematics attainment, educational level, preparedness to teach, and gender," *International Journal of Science and Mathematics Education*, vol. 21, no. 2, pp. 601-622, 2023.

[15] J. A. Alim, A. Fauzan, I. M. Arwana, and E. Musdi, "Model of geometry realistic learning development with interactive multimedia assistance in elementary school," presented at the Journal of Physics: Conference Series, IOP Publishing, 2020.

[16] N. Oumelaid, B. E. Boukari, and J. E. Ghordaf, "Assessing the impact of teacher characteristics, learner methods, and self-guided learning on technology adoption in mathematics instruction," *Multidisciplinary Science Journal*, vol. 7, no. 3, p. 2025110, 2025.

[17] I. Vale and A. Barbosa, "Active learning strategies for an effective mathematics teaching and learning," *European Journal of Science and Mathematics Education*, vol. 11, no. 3, pp. 573–88, 2023.

[18] D. N. Al Kharomah and M. Abduh, "The impact of the MathMagic learning method on students' mathematics cognitive learning outcomes," *Jurnal Elemen*, vol. 9, no. 1, pp. 120-131, 2023.

[19] D. Israwati, R. Johar, and B. Ansari, "The development of students' metacognition in mathematical problem-solving," in *AIP Conference Proceedings*, 2021.

[20] S. Xie and J. Cai, "Teachers' beliefs about mathematics, learning, teaching, students, and teachers: Perspectives from Chinese high school in-service mathematics teachers," *International Journal of Science and Mathematics Education*, vol. 19, no. 4, pp. 747-769, 2021.

[21] S. Samreen, N. Bi, and Y. Khajanchi, "The impact of teaching with schemas on structural word challenges," *Multidisciplinary Science Journal*, vol. 18, no. 5, p. ss0217, 2023.

[22] S. Maarif and N. Fitriani, "Mathematical resilience, habits of mind, and sociomathematical norms by senior high school students in learning mathematics: A structured equation model," *Infinity Journal*, vol. 12, no. 1, pp. 117-132, 2023. https://doi.org/10.22460/infinity.v12i1.p117-132

[23] K. Kamid, N. Huda, and W. Syafmen, "The relationship between students' mathematical disposition and their learning outcomes," *Journal of Education and Learning (EduLearn)*, vol. 15, no. 3, pp. 376-382, 2021.

[24] M. Leshin, T. LaMar, and J. Boaler, "Teachers' mixed implementation of mindset mathematics practices during and after a novel approach to teacher learning," *Education Sciences*, vol. 14, no. 11, p. 1229, 2024. https://doi.org/10.3390/educsci14111229

[25] A. Yorulmaz, H. Uysal, and H. Çokçaliskan, "Pre-service primary school teachers' metacognitive awareness and beliefs about mathematical problem solving," *Journal of Research and Advances in Mathematics Education*, vol. 6, no. 3, pp. 239-259, 2021.

[26] M. Chirove, D. Mogari, and U. I. Ogbonnaya, "Students' mathematics-related belief systems and their strategies for solving non-routine mathematical problems," *Waikato Journal of Education*, vol. 27, no. 3, pp. 101-121, 2022.

[27] A. Hidayat and T. Chao, "Unleashing mathematics teachers: Insights from a systematic literature review on digital learning in Indonesia," *Cogent Education*, vol. 12, no. 1, p. 2442868, 2025. https://doi.org/10.1080/2331186X.2024.2442868

[28] W. M. Lim, "What is qualitative research? An overview and guidelines," *Australasian Marketing Journal*, vol. 33, no. 2, pp. 199-229, 2025.

[29] M. A. Tashtoush, Y. Wardat, F. Aloufi, and O. Taani, "The effect of a training program based on TIMSS to developing the levels of habits of mind and mathematical reasoning skills among pre-service mathematics teachers," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 18, no. 11, p. em2182, 2022. https://doi.org/10.29333/ejmste/12557

[30] J. Hair and A. Alamer, "Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example," *Research Methods in Applied Linguistics*, vol. 1, no. 3, p. 100027, 2022. https://doi.org/10.1016/j.rmal.2022.100027

[31] F. Schuberth, M. E. Rademaker, and J. Henseler, "Assessing the overall fit of composite models estimated by partial least squares path modeling," *European Journal of Marketing*, vol. 57, no. 6, pp. 1678-1702, 2023.

[32] M. Fariha, R. Johar, R. Oktavia, and M. Mailizar, "Beliefs about the nature of mathematics and its effects on teaching and assessment of learning," presented at the 2nd Annual International Conference on Mathematics, Science and Technology Education (AICMSTE 2023), Atlantis Press, 2024.

[33] M. C. Howard and J. F. Hair Jr, "Integrating the expanded task-technology fit theory and the technology acceptance model: a multi-wave empirical analysis," *AIS Transactions on Human-Computer Interaction*, vol. 15, no. 1, pp. 83-110, 2023. https://doi.org/10.17705/1thci.00184

[34] Y. Hussein and C. Csíkos, "The effect of teaching conceptual knowledge on students' achievement, anxiety about, and attitude toward mathematics," *Eurasia Journal of Mathematics Science and Technology Education*, vol. 19, no. 2, p. em2226, 2023.

[35] A. Afthanorhan, P. L. Ghazali, and N. Rashid, "Discriminant validity: A comparison of CBSEM and consistent PLS using Fornell & Larcker and HTMT approaches," presented at the Journal of Physics: Conference Series, IOP Publishing, 2021.

[36] C. S. Sabanal, J. S. Bago, C. B. Balandra, and A. T. Miranda, "Attitudes toward Learning Mathematics and Performance of Grade 11 Students in the New Normal," *Asian Journal Educational Social Study*, vol. 50, no. 9, pp. 254-263, 2024. https://doi.org/10.9734/ajess/2024/v50i91585

[37] B. Hawash, U. Asma'Mokhtar, Z. M. Yusof, and M. Mukred, "The adoption of electronic records management system (ERMS) in the Yemeni oil and gas sector: Influencing factors," *Records Management Journal*, vol. 30, no. 1, pp. 1-22, 2020.

[38] D. Patkin and Y. Greenstein, "Mathematics anxiety and mathematics teaching anxiety of in-service and pre-service primary school teachers," *Teacher Development*, vol. 24, no. 4, pp. 502-519, 2020.

[39] G. Gullo, A. Gentile, B. Caci, and M. Alesi, "The role of teachers' conception of students' intelligence, self-efficacy and need frustration and satisfaction in shaping tendencies in teaching practices," *Teaching and Teacher Education*, vol. 160, p. 105033, 2025. https://doi.org/10.1016/j.tate.2025.105033

[40] J. Bosica, J. S. Pyper, and S. MacGregor, "Incorporating problem-based learning in a secondary school mathematics preservice teacher education course," *Teaching and Teacher Education*, vol. 102, p. 103335, 2021. https://doi.org/10.1016/j.tate.2021.103335

[41] R. Cohen and I. Katz, "Students' academic competence beliefs as an antecedent of perceived teachers' autonomy support and motivation: a longitudinal model," *Current Psychology*, pp. 1-12, 2024.

[42] D. Wettstein, R. Smith, and L. Johnson, "The role of teacher self-efficacy in classroom management and engagement strategies," *Journal of Educational Psychology*, vol. 113, no. 3, pp. 456-467, 2021.

[43] L. L. Warren, "The importance of teacher leadership skills in the classroom," *Education Journal*, vol. 10, no. 1, pp. 8-15, 2021.

[44] P.-J. Alegado and H. Soe, "A comparative analysis of the effects of mentoring among participating countries in 2013 and 2018 teaching and learning international survey (TALIS)," *International Journal of Research Studies in Education*, vol. 10, no. 5, pp. 45-59, 2021.