Interplay of Motivation and School Burnout in Predicting Mathematics Engagement: Evidence from Pre-Service Teachers

Christopher R. Vergara [1]

[1] *College of Education, Nueva Ecija University of Science and Technology, Philippines*

Abstract **– Mathematics engagement is critical in shaping academic outcomes and persistence. Research has shown that motivation and burnout are individual predictors of achievement, but there is limited research on their combined influence on mathematics engagement in the Philippine teacher education context. The present study examines the pre-service teacher mathematics engagement and its association with motivation and school burnout levels. Using a descriptive-correlational design, data were gathered from 128 pre-service teachers. The dataset was analyzed using descriptive statistics, complemented by Pearson's correlation and stepwise multiple linear regression. The results indicated that the pre-service teachers demonstrated high levels of mathematics motivation and engagement, while also showing a concerning prevalence of school burnout, most notably in the form of emotional exhaustion. Moreover, the results demonstrated that utility value, in conjunction with intrinsic value and self-regulation, served as significant determinants for engagement. Contrariwise, emotional exhaustion and cynicism acted as negative predictors against cognitive and emotional engagement. The study underscores the importance of early identification of burnout, implementing motivation-enhancing interventions, and integrating a holistic approach into mathematics education policies to sustain academic engagement and reduce attrition among pre-service teachers.**

Keywords **– Motivation, school burnout, mathematics engagement, pre-service teachers.**

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Corresponding author: Christopher R. Vergara,
College of Education, Nueva Ecija University of Science and Technology, Philippines
Email: sirvergara23@gmail.com

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1. Introduction

Academic failure and dropout rates in higher education remain significant challenges in the Philippines, undermining the nation's pursuit of sustainable development and educational equity. According to the 2023 report of the Commission on Higher Education (CHED), a disturbing 35.15% student dropout rate was observed, particularly in programs that require strong cognitive engagement, such as Mathematics [1]. Moreover, the Programme for International Student Assessment (PISA) indicates that Filipino learners rank among the lowest globally in mathematical literacy, pointing to an enduring difficulty in fostering deep mathematics engagement [2]. Over recent years, attention has increasingly turned to Positive Psychology as a potential response to this persistent concern, given its strength-based methodology that foregrounds resilience, motivation, and optimal functioning [3]. Central to this approach is the view that emotional regulation and meaningful engagement constitute key conditions for academic success, especially for individuals preparing to become future educators. Responding effectively to these issues requires a comprehensive account of the psychological factors shaping students' persistence and performance, with particular relevance to teacher education programs.

Mathematics motivation is widely understood as a multidimensional construct that substantially shapes students' engagement, persistence, and academic performance. It was conceptualized as comprising several interconnected dimensions: Intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety, each of which exerts a distinct influence on academic outcomes [4]. Empirical work has consistently reported that intrinsic value, self-regulation, and self-efficacy align with achievement goals and are associated with stronger mathematics achievement, whereas test anxiety functions as a maladaptive factor by weakening confidence and disrupting concentration [5], [6]. From the perspective of the Expectancy-value theory, students' motivation is grounded in both their expectations of success and the value they assign to tasks; when expectancy and value are high, learners typically invest greater effort and persist longer in mathematics [7].

In addition, motivation is strengthened when teacher autonomy support and instructional clarity are integrated, as these features promote psychological safety and facilitate cognitive engagement [8], [9], [10]. Learners' emotional responses, particularly enjoyment and anxiety, operate both as consequences of motivational processes and as mechanisms that further shape motivation, thereby affecting effort and persistence [11], [12]. Accordingly, identifying whether students are motivated by challenge, rewards, or social affirmation is essential for developing targeted interventions. Interventions that bolster positive motivational dimensions while simultaneously addressing test anxiety can meaningfully enhance students' mathematics learning experiences and outcomes.

By contrast, school burnout is defined by exhaustion, cynicism, and a perceived sense of inadequacy that develops in response to sustained academic pressures. Empirical research highlights that burnout is prevalent across both secondary and tertiary education, and is frequently associated with heavy workloads, heightened performance demands, and limited social-emotional support [13], [14]. At the individual level, resources such as self-efficacy and optimism have been identified as protective factors, as they help students manage stress more effectively and lessen burnout-related symptoms. Conversely, low self-esteem and poor teacher-student relationships are significant risk factors that can exacerbate burnout [15], [16]. The consequences of burnout are far-reaching, including declines in academic performance, school disengagement, absenteeism, and heightened depressive symptoms [17]. Burnout also impairs key cognitive functions such as attention and executive functioning, diminishing learning efficacy [18], [19]. Among mitigating factors, social support, especially from teachers and peers, consistently demonstrates the strongest protective effects [20]. Despite its substantial impact on student well-being and academic achievement, research on effective screening and intervention strategies for school burnout remains limited. Preventive efforts should thus prioritize the enhancement of self-efficacy, solution-focused coping skills, and robust school-based social support systems to reduce burnout and support academic and psychological health.

Mathematics engagement is likewise a multifaceted construct, comprising behavioral, emotional, cognitive, and social dimensions, with each dimension contributing in distinct ways to mathematics achievement. Behavioral and cognitive engagement are moderately correlated with academic performance, whereas emotional engagement, though sometimes inconsistently linked, plays a vital role in sustaining interest and participation [21], [22].

Recent research also highlights the predictive value of social engagement, emphasizing the importance of peer interactions and collaborative learning environments [23]. Teacher support is found to significantly influence all dimensions of engagement, often mediated by students' self-efficacy and emotions such as enjoyment [24]. Engagement is further maintained when students possess strong metacognitive skills, sustained interest, and effective self-regulation, with strengths in one area often compensating for weaknesses in another [25]. Nonetheless, disengagement persists, especially when instructional discourse lacks relevance or fails to activate intrinsic or instrumental motivation [26]. Students who are highly engaged are more inclined to use effective learning strategies, participate actively during lessons, and undertake higher-order thinking tasks. Maintaining this level of engagement, however, depends on sufficient academic ability, strong motivation, and the capacity to manage academic stress.

Despite the breadth of research on academic motivation and burnout, few studies have investigated how these constructs jointly influence mathematics engagement among pre-service teachers. Much of the existing literature treats motivation and burnout as independent predictors of academic outcomes, often neglecting their potential interplay. Furthermore, empirical studies within the Philippine context are scarce, despite unique socio-cultural, institutional, and economic factors shaping the student experience. Notably, there is a dearth of research focusing on future educators, whose attitudes and behaviors toward mathematics will ultimately shape the learning experiences of future generations.

This study seeks to respond to these gaps by investigating the dynamic interrelationship among mathematics motivation, school burnout, and mathematics engagement in a sample of Filipino pre-service teachers. In doing so, it aims to deepen understanding of the psychological factors that underpin mathematics learning in higher education. The research also produces locally relevant evidence that can support the design of interventions aligned with institutional and CHED policies for quality education. Taken together, the findings may inform the development of support systems intended to mitigate burnout, strengthen motivation and engagement, and, ultimately, improve retention and success rates within teacher education programs.

Focusing more precisely on this aim, the study investigates the complex relationships between mathematics motivation and school burnout as predictors of mathematics engagement among pre-service teachers in the Philippines. It is designed to produce actionable insights that can strengthen both policy and practice in teacher education and mathematics instruction.

Accordingly, the study is structured around three objectives: (1) To assess the levels of mathematics motivation, school burnout, and mathematics engagement; (2) To examine the intercorrelation among these variables; and (3) To determine significant predictors of mathematics engagement. By addressing these aims, the study advances empirically grounded recommendations intended to improve student engagement, mitigate academic failure and dropout, strengthen student well-being, and enhance mathematics education within teacher education institutions.

2. Methodology

This section outlines the methods and procedures used to conduct the study, including the research design, respondents, instrumentation, data collection procedures, and data analysis. The approaches described herein were carefully selected to ensure the validity, reliability, and overall integrity of the research findings.

2.1. Research Design

This investigation adopted a quantitative method, using a descriptive correlational design to examine both the levels of, and the relationships among, mathematics motivation, school burnout, and mathematics engagement in pre-service teachers. This design was selected because it enables the description of key psychological constructs and the examination of their associations without requiring variable manipulation. This approach is suitable for identifying patterns and predictors relevant to mathematics engagement in a natural academic context, enabling the researcher to generate empirically grounded insights applicable to real-world educational settings [27].

2.2. Respondents of the Study

The research involved 128 pre-service mathematics teachers who were selected through purposive sampling. The participants needed to be students in a teacher education program with a mathematics specialization at Nueva Ecija University of Science and Technology (NEUST) and have completed at least one year of coursework, as well as been actively engaged in academic activities during the data collection period. The targeted sampling method employed in this study ensured that all participants had sufficient academic exposure, providing valuable insights into their motivation, burnout, and engagement. The participants were from different year levels to ensure that a wide range of experiences from the pre-service training period were captured.

2.3. Research Instrument

This study utilized three standardized instruments to measure the variables under investigation, namely the mathematics motivation questionnaire (MMQ), the school burnout inventory (SBI), and the math and science engagement scales (MSES).

2.3.1. Mathematics Motivation

The MMQ was utilized to assess students' motivational orientations toward mathematics across five theoretically grounded domains: Intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety [4]. To enhance contextual relevance, responses were recorded on a five-point Likert scale from 1 (*never*) to 5 (*always*); a sample item is "*I am confident I will do well on math tests*". Evidence of reliability was strong, as the MMQ yielded high internal consistency, with Cronbach's α values between .73 and .89 (overall α = .85), alongside nonlinear SEM reliability coefficients ranging from .76 to .91 (overall ω = .90). Criterion validity was also supported: Intrinsic value, self-regulation, and self-efficacy were significantly and positively correlated with mathematics achievement, whereas test anxiety was significantly and negatively correlated.

2.3.2. School Burnout

The SBI was employed to evaluate academic exhaustion across three theoretically distinct subscales: Emotional exhaustion, cynicism toward school, and feelings of inadequacy [28]. To enhance contextual appropriateness for the local setting without compromising psychometric soundness, the instrument was adapted into a Likert-type response format, specifically a five-point scale ranging from 1 (*completely disagree*) to 5 (*completely agree*), with a representative item being *"I feel overwhelmed by my schoolwork."* The instrument demonstrated acceptable levels of internal consistency, as evidenced by reliability indices of Cronbach's α = .776 and ω = .787. Construct validity was further supported through theoretically anticipated correlations with related psychological constructs, affirming the SBI's appropriateness for application within higher education contexts.

2.3.3. Mathematics Engagement

To capture the multidimensional nature of mathematics engagement, the MSES was administered to assess four theoretically grounded dimensions: Behavioral, cognitive, emotional, and social engagement [25].

For the mathematics subscale, participants responded using a five-point Likert scale (1 = *never* to 5 = *always*); a representative item is "*I keep trying even if something is hard.*" The instrument exhibited excellent internal consistency (α = 0.93) and demonstrated strong predictive validity, with each engagement dimension contributing uniquely to academic outcomes. Further evidence of measurement invariance provided additional support for the instrument's robustness across diverse student populations.

2.4. Validity and Reliability of the Instrument

Instrument validity and reliability were thoroughly established. Table 1 presents the validity and reliability indices for each scale:

Content validity was examined using the content validity ratio (CVR) method, wherein six subject matter experts evaluated item relevance [29]. The resulting CVI of 1.00 across all scales indicated unanimous agreement regarding content appropriateness. In addition, evidence of reliability was obtained from a pilot test with 25 pre-service teachers, which produced overall Cronbach's alpha coefficients of .88 for Mathematics Motivation, .84 for School Burnout, and .91 for Mathematics Engagement, indicating good to excellent internal consistency. On this basis, the results support the suitability of the instruments for the study's target population.

Table 1. Validity and reliability of the instrument

Scale	Content Validity Index (CVI)	Verbal Description	Cronbach's Alpha	Verbal Description
Mathematics Motivation	1.00	Valid	.88	Good
School Burnout	1.00	Valid	.84	Good
Mathematics Engagement	1.00	Valid	.91	Excellent

2.5. Data Collection Procedure

Data collection followed established ethical and procedural standards. Permission was first secured from the dean and area chair, after which the researchers coordinated with subject teachers to arrange the in-class administration schedule. Prior to participation, students were provided with a concise orientation outlining the study's objectives, the voluntary nature of involvement, and guarantees of confidentiality. The validated instrument was then administered during regular class hours; item relevance and validity were established using Lawshe's method, and reliability was verified through a pilot test involving 25 respondents. Completing the survey took approximately 10–15 minutes, thereby limiting disruption to instructional time.

2.6. Data Analysis

The dataset was examined using both descriptive and inferential statistics. For the first research objective, mean score and standard deviations were calculated to characterize the levels of mathematics motivation, school burnout, and mathematics engagement among pre-service teachers. To address the second objective, Pearson's r correlation coefficient was employed to test the relationships among the three variables.

For the third objective, stepwise multiple linear regression analysis was used to determine significant predictors of mathematics engagement and to estimate the relative contribution of each factor to mathematics engagement outcomes.

Before conducting the regression, key assumptions were assessed. Evidence for linearity was obtained from scatterplots indicating linear associations between the independent variables (e.g., intrinsic value, emotional exhaustion) and the dependent variable (overall mathematics engagement). The Durbin–Watson statistic of 1.95 indicated independence of residuals. Homoscedasticity was evaluated via residual plots, which suggested stable variance across predicted values. Residual normality was supported by Q–Q plots and a Shapiro–Wilk test ($p > .05$), indicating no statistically significant deviation from a normal distribution. Finally, multicollinearity was not indicated, as Variance Inflation Factor (VIF) values ranged from 1.18 to 2.42 and tolerance values ranged from .41 to .85, all within acceptable limits.

3. Results

This section presents the empirical findings of the study, organized into three parts: The levels of mathematics motivation, school burnout, and mathematics engagement among pre-service teachers; the relationships among these variables; and the significant predictors of mathematics engagement.

3.1. Levels of Mathematics Motivation, School Burnout, and Mathematics Engagement among Pre-Service Teachers

Table 2 summarises the descriptive statistics for mathematics motivation, school burnout, and mathematics engagement among pre-service teachers, providing an integrated overview of their academic dispositions and associated challenges.

Table 2. Level of mathematics motivation, school burnout, and mathematics engagement of pre-service teachers

Variables	Mean	SD	Verbal Description
Mathematics Motivation			
Intrinsic value	4.00	.72	High
Self-regulation	4.13	.51	High
Self-efficacy	3.36	.62	Moderate
Utility value	4.18	.57	High
Test anxiety	3.84	.65	High
Overall Mathematics Motivation	3.54	.34	High
School Burnout			
Emotional exhaustion	4.41	.80	Very High
Cynicism	3.91	.83	High
Sense of Inadequacy	4.15	.78	High
Overall School Burnout	4.16	.72	High
Mathematics Engagement			
Cognitive Engagement	3.50	.40	High
Behavioral Engagement	3.94	.43	High
Emotional Engagement	3.77	.38	High
Social Engagement	4.31	.52	Very High
Overall Mathematics Engagement	3.86	.31	High

Overall, respondents reported a relatively high level of mathematics motivation ($M = 3.54$, $SD = .34$). Among the motivational dimensions, utility value ($M = 4.18$, $SD = .57$), self-regulation ($M = 4.13$, $SD = .51$), and intrinsic value ($M = 4.00$, $SD = .72$) emerged as the most salient, highlighting a potent combination of internal interest and recognition of the practical importance of mathematics.

Notably, test anxiety was also rated high ($M = 3.84$, $SD = .65$), indicating that while students are highly motivated, anxiety remains a significant coexisting factor that can both spur and hinder academic performance. In contrast, self-efficacy was rated as moderate ($M = 3.36$, $SD = .62$), reflecting some degree of uncertainty regarding confidence in mathematical competence.

Pre-service teachers also reported elevated levels of school burnout ($M = 4.16$, $SD = .72$). Emotional exhaustion was the most pronounced ($M = 4.41$, $SD = .80$), classified as "Very High," indicating widespread fatigue due to academic demands. Cynicism ($M = 3.91$, $SD = .83$) and a sense of inadequacy ($M = 4.15$, $SD = .78$) were also rated as "High," underscoring the prevalence of emotional strain and self-doubt within this group.

Concerning mathematics engagement, the overall mean was high ($M = 3.86$, $SD = .31$). Social engagement received the highest rating ($M = 4.31$, $SD = .52$), classified as "Very High," emphasizing the significance of collaborative learning and peer support in mathematics contexts. Behavioral ($M = 3.94$, $SD = .43$), emotional ($M = 3.77$, $SD = .38$), and cognitive engagement ($M = 3.50$, $SD = .40$) were all consistently high, suggesting that despite emotional fatigue, pre-service teachers remain actively, emotionally, and cognitively engaged in their mathematics learning experiences. These findings reveal a complex yet resilient engagement profile, shaped by strong motivation alongside substantial burnout.

3.2. Relationships among Mathematics Motivation, School Burnout, and Mathematics Engagement

Table 3 reports the correlation coefficients used to examine associations among the components of mathematics motivation, school burnout, and mathematics engagement.

Table 3. Correlational analysis of the relationship of mathematics motivation, school burnout, and mathematics engagement of pre-service teachers

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Intrinsic value	1											
2. Self-regulation	.126	1										
3. Self-efficacy	.480**	.400**	1									
4. Utility value	.353**	.391**	.369**	1								
5. Test anxiety	-.024	.243*	.221	.064	1							
6. Emotional exhaustion	.011	.158	.078	.063	.354**	1						
7. Cynicism	.100	-.089	-.022	-.116	.338**	.667**	1					
8. Sense of Inadequacy	.133	.114	.144	.020	.335**	.724**	.725**	1				
9. Cognitive Engagement	.160	.215	.049	.233*	-.185	-.334**	-.254*	-.114	1			
10. Behavioral Engagement	.185	.523**	.371**	.565**	.217	.156	-.132	.058	.261*	1		
11. Emotional Engagement	.477**	.170	.350**	.478**	.063	-.108	-.218	-.140	.076	.380**	1	
12. Social Engagement	.292*	.302**	.221	.417**	.220	.096	.047	.158	.262*	.551**	.509**	1

*Legend: *p < .05, **p < .01*

Overall, the results show that motivational constructs are significantly and positively related to multiple dimensions of engagement. Intrinsic value demonstrated a moderate relationship with emotional engagement (r = .477, p < .001) and social engagement (r = .292, p < .05), implying that students who enjoy mathematics are more emotionally invested and more inclined to collaborate with peers. Self-regulation displayed strong links with behavioral engagement (r = .523, p < .001) and social engagement (r = .302, p < .01), indicating that students who apply effective learning strategies tend to participate more actively and engage more with others. Self-efficacy was moderately correlated with behavioral engagement (r = .371, p = .001) and emotional engagement (r = .350, p = .002), reinforcing the role of confidence in shaping both performance-related involvement and affective investment. Utility value showed statistically significant correlations across all engagement domains, cognitive (r = .233, p < .05), behavioral (r = .565, p < .001), emotional (r = .478, p < .001), and social (r = .417, p < .001), underscoring its central importance in supporting broad-based engagement. By comparison, test anxiety did not exhibit significant associations with any engagement variable.

With respect to school burnout, emotional exhaustion was negatively associated with cognitive engagement (r = –.334, p = .004), suggesting that elevated fatigue undermines students' capacity to concentrate and process mathematical content.

Cynicism likewise showed a negative correlation with cognitive engagement (r = –.254, p = .029), reflecting how disengaged attitudes may reduce intellectual effort. In contrast, the sense of inadequacy was not significantly related to any engagement dimension, which may indicate a more diffuse or indirect influence.

3.3. Predictors of Mathematics Engagement

Table 4 synthesizes the outcomes of the stepwise multiple regression analysis by specifying the significant predictors for each dimension of mathematics engagement among pre-service teachers.

The regression results show that the overall model for cognitive engagement was significant (F = 8.047, p = .001), accounting for 18.5% of the variance (R^2 = .185). Emotional exhaustion was a significant negative predictor (β = –.377, p = .001), illustrating how heightened emotional fatigue impairs students' ability to concentrate and process mathematical content. Conversely, self-regulation positively predicted cognitive engagement (β = .274, p = .014), reinforcing the critical role of learning management strategies in promoting cognitive investment.

Table 4. Regression analysis of predictors of mathematics engagement

Variable	B	SE	Beta (β)	t	Sig.	R^2	F	p
Cognitive Engagement								
(Constant)	3.423	.396						
Emotional exhaustion	-.185	.053	-.377	-3.474	.001	.185	8.047	.001
Self-regulation	.217	.086	.274	2.529	.014			
Behavioral Engagement								
(Constant)	1.388	.357						
Utility value	.315	.072	.425	4.356	.000	.427	26.410	.000
Self-regulation	.299	.082	.357	3.653	.000			
Emotional Engagement								
(Constant)	2.461	.346						
Utility value	.213	.069	.315	3.100	.003	.384	14.523	.000
Intrinsic value	.205	.054	.388	3.820	.000			
Cynicism	-.102	.044	-.220	-2.306	.024			
Social Engagement								
(Constant)	2.694	.418						
Utility value	.385	.099	.417	3.894	.000	.174	15.161	.000

Behavioral engagement was significantly explained by a model accounting for 42.7% of the variance (F = 26.410, p < .001).

Within this model, utility value (β = .425, p < .001) and self-regulation (β = .357, p < .001) emerged as significant predictors, indicating that both perceptions of mathematics as useful and students' capacity for self-regulation are central to maintaining consistent, task-oriented academic behaviors.

For emotional engagement, the stepwise model accounted for 38.4% of the variance ($F = 14.523$, $p < .001$). Intrinsic value ($\beta = .388$, $p < .001$) and utility value ($\beta = .315$, $p = .003$) were positively associated with emotional engagement, whereas cynicism ($\beta = –.220$, $p = .024$) served as a significant negative predictor. These results emphasize the facilitating role of positive motivational orientations and the undermining effect of disengaged perspectives on affective involvement.

Finally, social engagement was predicted solely by utility value ($\beta = 0.417$, $p < .001$), with the model explaining 17.4% of the variance ($F = 15.161$, $p < .001$). This pattern underscores the importance of perceived relevance in fostering collaborative and supportive academic behaviors among pre-service teachers.

4. Discussion

This section interprets and contextualizes the empirical findings on the levels, relationships, and predictors of mathematics motivation, school burnout, and mathematics engagement among pre-service teachers, in light of the existing literature.

4.1. Levels of Mathematics Motivation, School Burnout, and Mathematics Engagement among Pre-Service Teachers

The study's findings show that pre-service teachers report generally high levels of mathematics motivation, with particularly strong ratings for utility value, self-regulation, and intrinsic value. This pattern indicates that learners' motivation is shaped both by the perceived practical benefits of mathematics and by internal drivers such as curiosity and personal enjoyment. Such results align with prior studies underscoring the substantial role of intrinsic and utility values in supporting academic engagement and achievement [30], [31]. Consistent with this, it was observed that although students often sustain motivation and interest in learning mathematics, they nonetheless commonly experience anxiety toward the subject. The coexistence of high motivation and elevated test anxiety highlights a more complex motivational landscape [32]. Although anxiety is often associated with reduced academic performance, the present findings suggest that it does not necessarily diminish students' interest in or perceived value of mathematics. Consistent with this view, prior studies contend that anxiety can negatively influence academic achievement while simultaneously coexisting with strong motivational beliefs [33], [34]. Furthermore, the pre-service teachers' moderate self-efficacy highlights that they believe they can solve math problems, but may still hesitate when problems seem complex.

Given the well-established role of self-efficacy as a predictor of academic achievement and negate mathematics anxiety [35], [36], [37], there is a critical need for targeted interventions that both address test anxiety and reinforce students' competence through mastery experiences. Instructional strategies tailored to reduce anxiety and build self-efficacy will likely sustain motivation and improve academic outcomes for pre-service teachers.

The findings further point to a troubling pattern of elevated school burnout among pre-service teachers, mirroring broader concerns about student mental health in higher education [38], [39]. Emotional exhaustion emerged as the most alarming expression of burnout, signaling the accumulated effects of sustained academic demands and ongoing stress. This was accompanied by marked cynicism and a strong sense of inadequacy, dimensions that have been shown to erode both motivation and self-perception [16], [17]. Building on this understanding, evidence suggests that such symptoms tend to intensify progressively over time, implying a gradual depletion of students' emotional and cognitive resources. [40], [28]. Although high academic demands are a primary driver of burnout, personal resources such as optimism and self-efficacy may buffer its impact [14], [15]. Likewise, robust external support, particularly from peers, family, and instructors, has been identified as a key protective factor [41]. If left unaddressed, burnout can substantially compromise academic performance and can also negatively shape students' perceptions of the institutional climate [42]. In line with this, a related study emphasizes that addressing personal fatigue and emotional exhaustion is essential for sustaining teachers' well-being and classroom effectiveness [43]. Collectively, these results point to an urgent need for systemic interventions in teacher education programs that build resilience, strengthen social support, and proactively reduce salient stressors.

Across cognitive, emotional, behavioral, and social domains, engagement levels were consistently high, suggesting that pre-service teachers are strongly involved in mathematics learning both intellectually and affectively. Notably, social engagement yielded the highest mean score, underscoring the central role of peer collaboration and interaction in enriching mathematical learning experiences. This pattern is consistent with prior research highlighting dialogue, shared problem-solving, and peer support as foundations for meaningful engagement [44], [45], [46]. The elevated behavioral, emotional, and cognitive engagement scores further indicate that pre-service teachers remain attentive, emotionally connected, and intellectually challenged by mathematical tasks.

These findings reinforce the view of engagement as a multidimensional construct that requires concurrent attention to students' actions, emotions, and thought processes [47], [48]. Comprehensive engagement is best fostered through instructional strategies that cultivate a mastery-oriented and supportive classroom climate, characterized by teacher enthusiasm, care, and responsiveness [49], [50].

4.2. Relationships among Mathematics Motivation, School Burnout, and Mathematics Engagement

The correlational results provide further clarification regarding how motivation aligns with engagement. Students who experience mathematics as enjoyable are more likely to report positive emotions and collaborate with peers, consistent with the positive correlations between intrinsic value and both emotional and social engagement. Enjoyment has likewise been linked to more positive self-perceptions, which in turn support deeper affective involvement and more interactive learning behaviors [51], [52]. In a similar vein, strong self-regulation has been shown to be significantly associated with behavioral and social engagement, fostering steady and constructive participation in collaborative activities [53]. In addition, self-efficacy was positively associated with emotional and behavioral engagement, highlighting the central role of confidence in sustaining effort and promoting a constructive learning disposition [54]. Utility value also showed a strong and consistent association with all engagement dimensions, suggesting that perceiving mathematics as relevant is linked to more comprehensive engagement [55]. By contrast, test anxiety was not significantly associated with any engagement domain, aligning with prior work that distinguishes performance-related stress from the motivational mechanisms underlying classroom engagement [56]. Overall, the findings underscore the importance of strengthening positive motivational beliefs to support robust and multidimensional engagement in mathematics learning.

Emotional exhaustion showed a significant negative association with cognitive engagement, indicating that mental fatigue reduces students' capacity to sustain attention and process mathematical content effectively. Consistent findings have been reported in the literature, emphasizing the adverse impact of exhaustion on academic engagement [57], [58]. Notably, the absence of significant links between emotional exhaustion and the other engagement forms suggests that its influence is largely internalized, manifesting primarily as reduced cognitive effort.

In a similar vein, cynicism was negatively correlated with cognitive engagement, reinforcing the view that disaffected attitudes weaken intellectual investment in mathematics [59]. By contrast, feelings of inadequacy did not display significant associations with the dimensions of mathematics engagement. This pattern suggests that negative self-perceptions alone may not directly suppress engagement unless they co-occur with other adverse emotional states, such as exhaustion or cynicism. Taken together, the findings point to the importance of interventions that directly address emotional exhaustion and cynicism to strengthen cognitive engagement and support academic success in mathematics.

4.3. Predictors of Mathematics Engagement

Regression analyses offered further evidence regarding the determinants of mathematics engagement. Emotional exhaustion emerged as a significant negative predictor of cognitive engagement, reinforcing that elevated emotional fatigue undermines pre-service teachers' capacity to maintain attention and engage in complex cognitive processing, particularly in mathematically demanding contexts [60]. In contrast, self-regulation was identified as a significant positive predictor of cognitive engagement, indicating that pre-service teachers who manage their learning processes effectively not only achieve better academically but may also experience lower emotional exhaustion. This pattern aligns with prior evidence emphasizing the protective role of self-regulatory skills against academic burnout [61], [62]. Furthermore, self-regulation has been shown to contribute to the development of academic self-efficacy and to promote the use of deep learning strategies, both of which are central to sustained cognitive engagement [63], [64].

Utility value and self-regulation were also found to predict behavioral engagement significantly. Students who recognize the practical value of mathematics and employ goal-oriented learning strategies are more likely to participate actively and consistently in class [65], [66]. This aligns with contemporary engagement models emphasizing the interplay of motivation, self-regulation, and contextual supports [67], [68]. Similarly, both intrinsic and utility values emerged as significant predictors of emotional engagement, with pre-service teachers who enjoy mathematics and recognize its practical relevance demonstrating greater emotional investment [69]. Conversely, cynicism was a negative predictor of emotional engagement, indicating that skeptical or disengaged attitudes diminished affective connections to learning [70], [71].

Finally, the study revealed that utility value emerged as the most significant factor predicting social engagement, as pre-service teachers who find meaning and relevance in mathematics tend to work constructively with their peers.

Perceived relevance has been shown to motivate students toward social interaction and collaborative learning [72], [73]. This dynamic is further reinforced by teacher-student rapport, as supportive relationships have been found to affirm the subject's importance while simultaneously encouraging cooperative academic behaviors [74], [75]. The research findings demonstrate that utility value and self-regulation play essential roles in all engagement domains, which supports teaching methods that promote relevance, autonomy, and emotional support to develop comprehensive mathematics engagement in pre-service teachers.

Collectively, these findings carry both theoretical and practical implications for mathematics education and teacher preparation. From a theoretical standpoint, the results reinforce established frameworks such as expectancy-value theory and self-regulation theory by demonstrating that perceived utility, intrinsic value, and self-regulation function as key determinants of pre-service teachers' mathematics engagement. In addition, the documented negative effects of emotional exhaustion and cynicism on pre-service teachers' cognitive and emotional engagement provide further support for the cognitive-affective model of burnout, underscoring the need to attend to students' emotional well-being alongside their academic motivation.

In practical terms, the evidence points to the value of adopting a more holistic orientation within teacher education programs. Beyond developing mathematical competence, programs should incorporate strategies that build resilience, strengthen self-regulation, and increase the perceived relevance of mathematics through real-life applications, collaborative learning opportunities, and comprehensive wellness support systems. In this way, educators may reduce burnout, sustain academic engagement, and more effectively prepare pre-service teachers to cultivate meaningful learning environments in their future classrooms.

5. Conclusion

The study provides important evidence on the dynamic relationships among mathematics motivation, school burnout, and mathematics engagement in pre-service teachers, thereby extending the existing literature in several ways. First, the results indicate that pre-service teachers reported high levels of both motivation and engagement, with particularly strong scores in utility value, intrinsic value, and social engagement.

At the same time, the data also show a notable presence of elevated emotional exhaustion and test anxiety. Taken together, this pattern suggests that while pre-service teachers are highly determined and committed, they may simultaneously remain susceptible to burnout and anxiety. Further analyses demonstrated that motivational factors, especially utility value, intrinsic value, and self-regulation, served as significant positive predictors across multiple domains of mathematics engagement. By contrast, emotional exhaustion and cynicism emerged as prominent negative predictors, highlighting how emotional vulnerabilities can constrain academic engagement. In practical terms, when pre-service teachers perceive mathematics as useful and relevant, experience genuine enjoyment in learning it, and employ effective strategies to monitor and regulate their learning, they are more likely to demonstrate stronger engagement. Conversely, experiences of fatigue, detachment, or diminished enthusiasm appear to reduce their capacity to engage meaningfully in mathematics. Overall, the findings indicate that mathematics engagement reflects a complex interplay between motivational strengths and emotional challenges, offering empirical support for expectancy-value theory and the cognitive-affective model of burnout. Accordingly, the study points to the need for a holistic teacher education framework that not only promotes academic achievement but also attends to motivation and engagement, while integrating psychological support for mental health to help pre-service teachers sustain enthusiasm alongside emotional balance.

Grounded on the key findings, the study recommends strategic actions and directions to enhance mathematics engagement among pre-service teachers. First, the university's faculty development program is encouraged to equip faculty members with the necessary knowledge and skills to integrate motivation-oriented pedagogies that emphasize the utility and intrinsic value of mathematics through real-life applications, collaborative tasks, and inquiry-based learning to sustain engagement. Moreover, institutions must address the prevalence of emotional exhaustion, cynicism, and test anxiety among pre-service teachers. The university may institutionalize mental health and well-being programs and establish mechanisms for early detection of students at risk of burnout, as well as provide access to mental health services, such as counseling services, stress management training, and enhanced peer support systems. Furthermore, it is vital to develop self-regulation skills in pre-service teachers through structured training in reflective practice, time management, and coping strategies, to help them manage academic pressures effectively.

To ensure long-term impact, teacher education must adopt a holistic framework that balances pedagogical and content mastery with the development of socio-emotional competencies, supported by adequate resources and interventions designed to sustain enthusiasm and engagement. Future studies may adopt longitudinal and mixed-methods designs to examine causal pathways and to develop context-specific interventions that sustain engagement while mitigating burnout over time. This line of inquiry would enable a more comprehensive understanding of the interplay among motivation, burnout, and engagement in pre-service teachers.

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