



Digital Competence, Self-Efficacy, Academic Stress and Perceived Mathematical Problem-Solving Ability Among Madrasah Aliyah Students

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Abstract

Mathematics performance among Indonesian students remained a pressing concern, yet the joint contribution of digital competence, academic stress, self-efficacy, and academic burnout to students' perceived mathematical problem-solving ability had rarely been examined together. This study examined these relationships among 515 Madrasah Aliyah students in Jambi Province, selected through stratified random sampling and analysed using Partial Least Squares Structural Equation Modelling via SmartPLS. Self-efficacy was the strongest predictor of perceived problem-solving ability ($\beta = 0.397$, $p < 0.001$) but, contrary to expectations, was also positively associated with academic stress ($\beta = 0.369$, $p < 0.001$) and academic burnout ($\beta = 0.133$, $p = 0.002$), suggesting a dark side of high self-belief under competitive conditions. Academic burnout showed an unexpected positive association with perceived ability ($\beta = 0.184$, $p < 0.001$), interpreted as a possible suppression effect. Digital competence was modestly associated with perceived ability ($\beta = 0.116$, $p < 0.01$) but not with stress or burnout, while academic stress was the strongest predictor of burnout ($\beta = 0.446$, $p < 0.001$). The model explained 35.5% of the variance in perceived ability. Psychological resilience mattered more for perceived mathematical competence than digital skills alone, supporting policies pairing digital literacy with stress-regulation support for high-efficacy students.

Keywords: academic burnout; digital competence; mathematical problem-solving; PLS-SEM; self-efficacy



INTRODUCTION

Mathematical problem-solving ability (MP-SA) is a critical competency at the core of modern mathematics education. The National Council of Teachers of Mathematics (NCTM, 2000) affirms that problem-solving is not merely an end goal of learning but the primary vehicle through which students construct and develop mathematical knowledge (Liljedahl, 2021). At its most fundamental level, Polya (1957) defines this process as the effort to find a way out of a difficulty, a dynamic phase in which students must exert effort to navigate obstacles towards a goal that cannot be reached instantaneously. This definition remains foundational in contemporary mathematical education research (Schoenfeld, 2022). Implicitly, problem-solving demands not only cognitive proficiency but also triggers significant psychological responses. The encounter with obstacles and difficulties requires strong self-belief and potentially generates mental tension. From the OECD's perspective, mathematical problem-solving is adopted as one of the primary indicators within the PISA mathematical literacy framework, assessing the extent to which students can employ mathematical reasoning to resolve real-world and contextual problems (OECD, 2023). Within the Indonesian educational context, problem-solving ability serves as a benchmark of academic quality and an indicator of students' readiness to face the challenges of the digital era (Valverde-Berrocso et al., 2022). Nevertheless, a significant gap persists between curricular aspirations and the actual achievement of Indonesian students (Wawan & Retnawati, 2022), demanding a comprehensive evaluation of the factors determining this competency. This gap is not merely a pedagogical issue. It reflects the complex interplay between cognitive, affective, and learning environment factors that has yet to be systematically mapped in Indonesian mathematics education research.

Among the factors contributing to this gap, the rapid digitalisation of education has introduced a new and increasingly critical dimension into mathematics learning. Proficiency in calculation alone is no longer sufficient. Students are now required to harness technology intelligently to support mathematical thinking. Empirical evidence from PISA 2022 data demonstrates that the way students use digital tools rather than mere access to them, constitutes a significant predictor of mathematical ability (Joshi et al., 2025). In online learning environments, digital readiness becomes a prerequisite before conceptual understanding can occur (Wagiran et al., 2022). Digital competence is therefore now positioned as an important determinant of academic success (Cabero-Almenara et al., 2022). Recent research indicates that adequate digital literacy can indirectly enhance problem-solving ability by reducing students' cognitive load (Skulmowski & Xu, 2022). When students are no longer hindered by technical obstacles in device usage, their anxiety decreases, allowing their cognitive capacity (working memory) to be fully allocated to substantive mathematical processing (Cuder et al., 2023). Even so, the effect of digital competence on problem-solving ability is not always linear. A meta-analysis indicates that the effect of technology on mathematics achievement depends heavily on the quality of the accompanying pedagogical integration (Ran et al., 2022).

The constant pressure to adapt to technological demands frequently burdens students psychologically, particularly in a subject that intrinsically requires high-level reasoning such as mathematics. Academic stress represents a psychological response to learning demands that can actively inhibit problem-solving ability. Large-scale meta-analyses confirm a significant negative correlation between mathematics anxiety and students' mathematical performance (Ulum & Küçükdanaci, 2022). The primary mechanism is cognitive interference, anxiety occupies working memory capacity that would otherwise be directed toward mathematical problem-solving (Cuder et al., 2023). In cognitive terminology, this phenomenon is explained by Attentional Control Theory (Eysenck et al., 2007; González-Gómez et al., 2023), which posits that anxiety directs attention toward threatening stimuli, such as fear of failure or negative evaluation rather than toward the mathematical reasoning required. As a result, anxious students often fail to demonstrate their true mathematical potential, not due to a lack of ability, but because their cognitive processes are distorted by emotional burden. This phenomenon is persistent. Longitudinal studies indicate that unaddressed mathematics anxiety develops into a chronic barrier accompanying students throughout their entire educational trajectory (Szczygieł, M., & Pieronkiewicz, 2022).

When stress is left unaddressed, it can escalate into academic burnout. A condition characterised by the depletion of physical, emotional, and cognitive resources due to prolonged academic demands (Ali et al., 2025). In this study, academic burnout is defined, following Salmela-Aro et al. (2009), as a syndrome of exhaustion, cynicism, and reduced academic efficacy resulting from chronic academic demands, conceptually distinct from transient fatigue, a short-term state of tiredness that dissipates with rest. The School Burnout Inventory (SBI) used here measures this syndrome rather than momentary tiredness; the term "burnout" is therefore used consistently throughout this manuscript, including in the title, hypotheses, tables, and discussion. Academic burnout not only diminishes learning motivation but also weakens students' metacognitive capacity, including the ability to monitor, regulate, and evaluate their own thinking processes, which constitutes an essential component of effective mathematical problem-solving (Madigan & Curran, 2021).

Amid these pressures, self-efficacy emerges as the most protective psychological resource. Students' belief in their ability to complete mathematical tasks has been shown to predict success more powerfully than study habits alone (Asanre et al., 2024). High self-efficacy promotes persistence when facing difficult problems, deepens mathematical comprehension and problem-solving ability (Asare et al., 2025), and stimulates mathematical creativity (Herianto et al., 2024). Bandura's foundational concept that self-efficacy determines the choice of activities, the amount of effort expended, and resilience in facing failure, has been empirically demonstrated to remain a powerful direct predictor in contemporary mathematical problem-solving contexts (Al Umairi, 2024). At the classroom level, this relationship between psychological confidence and mathematical performance has been empirically observed: students with higher confidence tend to meet more indicators of mathematical ability, while those with lower confidence consistently struggle to perform in problem-solving tasks (Aulia et al., 2021).

Students with high self-efficacy tend to adopt more complex problem-solving strategies, resist giving up when encountering obstacles, and use failure as information to refine their subsequent approach. Conversely, students with low self-efficacy tend to avoid challenges, surrender quickly, and become trapped in a cycle of failure that reinforces negative beliefs about their own abilities (Zakariya, 2022). Furthermore, self-efficacy functions as a psychological buffer that moderates the impact of stress on burnout (Gao, 2023). Within the local context of Jambi Province, this variable has been identified as a key determinant of students' mathematical success (Ramadhanti et al., 2025), positioning self-efficacy not merely as a predictor variable but as a strategic intervention point capable of simultaneously strengthening problem-solving ability and mitigating the destructive impact of stress and academic burnout.

Prior research has generally examined these variables in isolation. An integrative model that simultaneously links digital competence, academic stress, self-efficacy, and academic burnout with mathematical problem-solving ability remains scarce in the post-pandemic literature. Building upon the model proposed by Madrilejos (2025), this study aims to fill that gap. Existing research has frequently captured only the relationship between two or three variables, thus failing to capture the more complex and mutually influencing interaction dynamics. In the reality of classroom learning, these four factors do not operate in isolation: digital competence can exacerbate or alleviate stress depending on the quality of its integration; accumulated stress triggers burnout; self-efficacy moderates the entire chain; and burnout ultimately shapes or inhibits problem-solving ability. Without a model capable of capturing these simultaneous interconnections, resulting intervention recommendations will remain insufficiently comprehensive and potentially misdirected.

Building on Hendra et al. (2025), who modelled perfectionism, self-efficacy, academic stress, and workload as predictors of academic burnout and achievement in an Indonesian higher-education sample, and on Madrilejos (2025), who proposed the base structural framework adapted here, the present study extends this line of work by (a) situating the model within the Madrasah Aliyah context in Jambi Province, and (b) incorporating digital competence as an additional exogenous predictor alongside the psychological pathway. This study poses the central question: how do digital competence, self-efficacy, academic stress, and academic burnout, both partially and simultaneously, relate to Madrasah Aliyah students' perceived mathematical problem-solving ability in Jambi Province? Based on the preceding literature review, nine hypotheses were formulated as follows.

H1: Self-efficacy has a significant negative effect on academic stress

- H2: Self-efficacy has a significant negative effect on academic burnout.
H3: Self-efficacy has a significant positive effect on mathematical problem-solving ability.
H4: Digital competence has a significant negative effect on academic stress.
H5: Digital competence has a significant negative effect on academic burnout.
H6: Digital competence has a significant positive effect on mathematical problem-solving ability.
H7: Academic stress has a significant positive effect on academic burnout.
H8: Academic stress has a significant negative effect on mathematical problem-solving ability.
H9: Academic burnout has a significant negative effect on mathematical problem-solving ability.

Although H1, H2, H4, and H5 predict negative relationships based on the theoretical literature reviewed above, we note a priori that self-efficacy's relationship with stress-related outcomes may be more complex under high-pressure academic conditions; this possibility is revisited in the Discussion in light of the results.

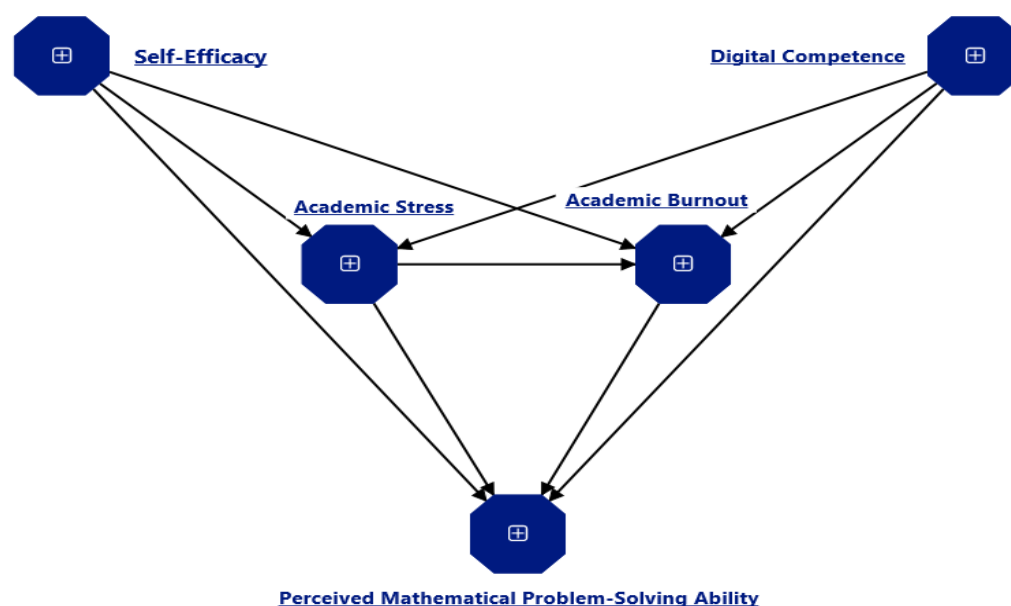


Figure 1. Proposed Research Model

METHOD

This study adopted a quantitative research design with a causal-survey approach to examine the directional relationships among digital competence, self-efficacy, academic stress, academic burnout, and mathematical problem-solving ability among Madrasah Aliyah students in Jambi Province, Indonesia. Data were collected between February and April 2025. The accessible population consisted of 61,852 students enrolled in State and Private Madrasah Aliyah (Islamic Senior High Schools) across Jambi Province, based on enrollment data from the Ministry of Religious Affairs of the Republic of Indonesia (Badan Pusat Statistik Provinsi Jambi, 2025).

The minimum required sample size was estimated using G*Power 3.1 (Erdfelder et al., 2009; Hair et al., 2022), with the following parameters: effect size $f^2 = 0.15$ (medium effect; Cohen, 1988), statistical power $(1-\beta) = 0.95$, alpha level $(\alpha) = 0.05$, and four predictor variables pointing to the endogenous construct with the greatest number of incoming paths (Academic Burnout), yielding a minimum required sample size of 129 respondents. The final sample of 515 participants substantially exceeded this threshold, enhancing the statistical power of the analyses. This study complied with ethical standards for research involving human subjects. Written informed consent was obtained from all participants and/or their legal guardians prior to data collection. Participant confidentiality was maintained throughout the study.

Demographic analysis revealed a relatively balanced though female-dominated sample, with 308 female students (59.8%) and 207 male students (40.2%). In terms of grade level, the sample was distributed across all three levels, with the largest proportion from Grade 10 ($n = 215$, 41.7%), followed by Grade 12 ($n = 183$, 35.5%) and Grade 11 ($n = 117$, 22.7%). The majority of respondents (93.8%, $n = 483$) attended State Madrasah Aliyah, reflecting the predominant characteristics of the madrasah education system in the region. This sample heterogeneity provides a reasonable, though not fully probability-based, foundation for interpreting findings in relation to the broader population of Madrasah Aliyah mathematics learners in the province.

Table 1. Respondent Demographic Profile

Category	Sub-Category	Frequency (N)	Percentage (%)
Gender	Male	207	40.2
	Female	308	59.8
Grade Level	Grade X	215	41.7
	Grade XI	117	22.7
	Grade XII	183	35.5
School Status	Public (MAN)	483	93.8
	Private	32	6.2
Total	—	515	100.0

Grade XI is somewhat under-represented relative to the other levels; while stratified sampling minimises systematic bias, this imbalance is noted as a factor to consider when generalising findings across grade levels, and is revisited in the Limitations section. To ensure proportional representation across these strata, stratified random sampling was applied based on gender, grade level, and school status (state/private). This methodological step helped reduce selection bias and supports cautious generalisation of the findings to the broader Madrasah Aliyah student population in the province, within the limitations noted above.

Although this demographic diversity provides a comprehensive profile of the respondents, the study did not explicitly examine the moderating effects of these demographic variables on the primary constructs. Instead, the analytical focus remained on testing the structural model of relationships among psychological and competence-related variables. Nevertheless, the sample heterogeneity enriches the study's external validity by capturing nuanced mathematics learning behavior trends across multiple educational levels.

To examine the complex hypothesised model, quantitative data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) via SmartPLS 4.0 (Ringle et al., 2024). PLS-SEM was selected over Covariance-Based SEM (CB-SEM) for three key reasons: (1) its robustness in handling non-normally distributed data, (2) its suitability for predictive and theory-building purposes, and (3) its efficiency in estimating complex path models with multiple latent constructs (Hair et al., 2022; Sarstedt et al., 2021). This approach is particularly appropriate given the study's objective of predicting structural relationships among exogenous latent variables (Digital Competence and Self-Efficacy) and endogenous variables (Academic Stress, Academic Burnout, and Mathematical Problem-Solving Ability).

The research instrument consisted of five Likert-scale measurements. Digital Competence (DC) was measured using 15 items adapted from the DigComp 2.2 framework (Vuorikari et al., 2022) and the digital literacy instrument of Lukitasari et al. (2022). Academic Stress (AS) was assessed through 10 items based on the *Educational Stress Scale for Adolescents* (ESSA) developed by Sun et al. (2011), with cross-cultural validation evidence provided by Moustaka et al. (2023). Self-Efficacy (SE) was measured using 8 items constructed from Bandura (1997) theory and the indicators of Hendra et al. (2025). Academic Burnout (AB) was assessed with 9 items from the *School Burnout Inventory* (SBI) by Salmela-Aro et al. (2009). Mathematical Problem-Solving Ability (MP-SA) was gauged through 5 perceptual achievement indicators aligned with Hendra et al. (2025). All items were rated on a five-

point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), consistent with established psychometric framework (Jebb et al., 2021).

To ensure linguistic and conceptual accuracy, the instrument underwent a back-translation procedure from English to Indonesian. Content validity was further confirmed through expert judgment evaluating the relevance, clarity, and simplicity of each item; the resulting Content Validity Index (CVI) exceeded the 0.80 threshold recommended by Polit and Beck (2006), confirming the instrument's suitability for field data collection. The full item list is provided in the Appendix. The full item list, together with the cross-cultural adaptation and back-translation procedure applied to the DigComp, ESSA, and SBI instruments, is provided in Appendix A.

Prior to hypothesis testing, Common method bias was assessed using the full collinearity approach recommended for PLS-SEM (Kock, 2015), in which inner VIF values are examined for all predictor constructs. All inner VIF values ranged from 1.124 to 1.544, well below the conservative threshold of 3.3, suggesting that common method bias is unlikely to be a serious concern in this study. The analytical procedure comprised two stages is evaluation of the *outer model* (measurement model) and evaluation of the *inner model* (structural model). Path significance was tested through bootstrapping with 5,000 sub-samples, examining path coefficients (β), t-statistics, and p-values. Model quality was evaluated using R^2 , Q^2 , f^2 , and SRMR.

RESULTS

Measurement Model Assessment

Prior to structural model testing, the measurement model was assessed to ensure construct validity and reliability. Three items were eliminated for failing to meet the minimum outer loading threshold of 0.70: AS7 ($\lambda = 0.619$), AS10 ($\lambda = 0.320$), and AF9 ($\lambda = 0.468$). The final measurement model retained 44 valid indicators with outer loadings ranging from 0.711 to 0.913. As presented in Table 2, all constructs satisfied the criteria for convergent validity ($AVE > 0.50$) and composite reliability ($CR > 0.70$; Cronbach's $\alpha > 0.70$), consistent with guidelines established by Hair et al. (2022), as summarised in Table 2.

Table 2. Measurement Model Evaluation Summary

Construct	CR (pc)	Cronbach's α	AVE	Loading Range
Digital Competence (DC)	0.977	0.975	0.740	0.844–0.877
Academic Stress (AS)	0.928	0.911	0.577	0.711–0.913
Self-Efficacy (SE)	0.931	0.915	0.627	0.762–0.885
Academic Burnout (AB)	0.936	0.923	0.622	0.725–0.858
Mathematical Problem-Solving Ability	0.899	0.859	0.641	0.719–0.856

Note: CR = Composite Reliability; AVE = Average Variance Extracted

Having confirmed adequate reliability and validity of the measurement model, the analysis proceeded to evaluate the structural integrity of the model. The Digital Competence construct showed very high reliability ($CR = 0.977$; $\alpha = 0.975$), exceeding the level typically expected for 15 indicators; this may reflect a degree of item redundancy or homogeneous response patterns rather than an unusually robust construct, and could be explored through item reduction in future instrument refinement. Taken together, these preliminary results support the suitability of proceeding to a deeper discriminant evaluation.

Discriminant Validity and Model Fit

All constructs met the requirements for convergent validity ($AVE > 0.50$) and reliability ($CR > 0.70$; Cronbach's $\alpha > 0.70$). Discriminant validity was assessed using the Heterotrait-Monotrait (HTMT) ratio of correlations. All HTMT values fell below the conservative threshold of 0.85 (range: 0.07–0.55), confirming that the five constructs are empirically distinct (discriminant validity). Collinearity among predictor constructs was assessed separately using inner VIF values (see Common Method Bias

subsection above), all of which were below 3.3. The complete empirical matrix demonstrating these distinct properties across all evaluated latent constructs is detailed in Table 3.

Table 3. Discriminant Validity Matrix (HTMT Ratio)

Construct	AB	AS	DC	MP-SA	SE
Academic burnout (AB)	—				
Academic Stress (AS)	0.552	—			
Digital Competence (DC)	0.073	0.166	—		
Mathematical Problem-Solving Ability	0.353	0.315	0.308	—	
Self-Efficacy (SE)	0.277	0.332	0.417	0.548	—

Upon confirming the adequacy of the measurement model, the structural model's overall goodness-of-fit was evaluated to ensure the robust specification of the structural framework. The corresponding metrics, evaluating the model's explanatory and predictive capacities, are systematically organised in Table 4.

Table 4. Structural Model Fit Indices

Index	Estimated Value	Recommended Threshold	Status
SRMR	0.061	< 0.08	Good Fit

As shown in Table 4, the SRMR value of 0.061 fell below the 0.08 threshold commonly regarded as indicating an acceptable fit for PLS path models (Hair et al., 2022; Henseler et al., 2016). Given that even correctly specified PLS models can yield SRMR values approaching or exceeding 0.06 (Henseler et al., 2016). Chi-square-based fit statistics and bootstrap-based exact-fit indices (d_ULS, d_G) are not reported, as SRMR is considered the primary and most established fit criterion for variance-based PLS-SEM (Hair et al., 2022).

Hypothesis Testing

Structural model hypotheses were tested using a bias-corrected and accelerated (BCa) bootstrapping procedure with 5,000 resamples, as recommended for PLS-SEM inference (Hair et al., 2022). Path coefficients (β), t-statistics, and p-values are reported in Table 5. Effect sizes (f^2) were interpreted using Cohen (1988) benchmarks: small ($f^2 \geq 0.02$), medium ($f^2 \geq 0.15$), and large ($f^2 \geq 0.35$).

Table 5. Structural Model Hypothesis Testing Results

Hyp.	Path	β	t-Statistics	p-Value	f^2	Decision
H1	Self-Efficacy $\rightarrow$ Academic Stress	0.369	6.926	< 0.001	0.142	Not Supported (significant, opposite direction)
H2	Self-Efficacy $\rightarrow$ Academic Burnout	0.133	3.168	0.002	0.019	Not Supported (significant, opposite direction)
H3	Self-Efficacy $\rightarrow$ Perceived Problem-Solving Ability	0.397	10.525	< 0.001	0.165	Supported
H4	Digital Competence $\rightarrow$ Academic Stress	0.047	0.730	0.465	0.002	Not Supported
H5	Digital Competence $\rightarrow$ Academic Burnout	-0.084	1.718	0.086	0.008	Not Supported
H6	Digital Competence $\rightarrow$ Perceived Problem-Solving Ability	0.116	2.663	0.008	0.015	Supported
H7	Academic Stress $\rightarrow$ Academic Burnout	0.446	13.414	< 0.001	0.231	Supported
H8	Academic Stress $\rightarrow$ Perceived Problem-Solving Ability	0.033	0.963	0.336	0.001	Not Supported
H9	Academic Burnout $\rightarrow$ Perceived Problem-Solving Ability	0.184	4.675	< 0.001	0.038	Not Supported (significant,

Hyp.	Path	β	t-Statistics	p-Value	f ²	Decision
						opposite direction)

Note: p-values below 0.001 are reported as "< 0.001". H1, H2, and H9 were hypothesised as negative but yielded significant positive coefficients; per convention for directional hypothesis testing, these are classified as not supported despite statistical significance, and are discussed as theoretically important unexpected findings. H5 was not statistically significant ($p = 0.086$) despite its negative coefficient.

Self-efficacy was confirmed as the strongest predictor of perceived problem-solving ability (H3: $\beta = 0.397$, $p < 0.001$). Contrary to the hypothesised negative direction, self-efficacy was significantly and positively associated with both academic stress (H1: $\beta = 0.369$, $p < 0.001$) and academic burnout (H2: $\beta = 0.133$, $p = 0.002$); accordingly, H1 and H2 are classified as not supported despite statistical significance. This unexpected finding warrants theoretical interpretation and is discussed in detail in the Discussion. Digital competence showed a significant positive association with problem-solving ability (H6: $\beta = 0.116$; $p = 0.008$). But showed no significant association with academic stress (H4: $p = 0.465$); accordingly, H4 was not supported. This suggests that digital competence functions primarily as an academic leverage tool rather than a psychological coping mechanism, since academic stress among mathematics learners is more fundamentally rooted in content complexity, fear of failure, and intrinsic mathematics anxiety, factors that remain present regardless of students' digital proficiency level (Ran et al., 2022).

Similarly, H5 is rejected, as digital competence did not significantly reduce academic burnout. The borderline p-value ($p = 0.086$) suggests a weak trend but falls short of statistical significance. This outcome reinforces the view that academic burnout in high-performing students is driven more by sustained cognitive effort and self-imposed workload than by digital obstacles (Madigan & Curran, 2021). Digitally competent students may even experience greater burnout because their proficiency enables them to engage more intensively with academic tasks. Academic stress was the primary predictor of academic burnout (H7: $\beta = 0.446$; $p < 0.001$) but showed no significant direct association with problem-solving ability (H8: $p = 0.336$). H8 was therefore not supported. Academic stress does not exert a direct, statistically significant effect on problem-solving ability ($\beta = 0.033$; $p = 0.336$). This does not mean stress is irrelevant; rather, its association with perceived problem-solving ability may operate indirectly through academic burnout. A specific indirect effect test (Academic Stress $\rightarrow$ Academic Burnout $\rightarrow$ Perceived Problem-Solving Ability) yielded $\beta = 0.107$, $t = 3.672$, $p < 0.001$, 95% CI [0.052, 0.166], based on bootstrapped confidence intervals not containing zero, supporting a mediated pathway consistent with Zhao et al. (2010) criteria for indirect-only mediation. Students may therefore develop a degree of tolerance or adaptive response to moderate academic stress, preventing it from directly impairing their mathematical performance in the short term (González-Gómez et al., 2023). Academic burnout showed a significant positive association with problem-solving ability (H9: $\beta = 0.184$; $p < 0.001$).

Model Predictive Power

Table 6. Coefficient of Determination and Predictive Relevance

Endogenous Variable	R ²	R ² Category	Q ²
Mathematical Problem-Solving Ability (MP-SA)	0.355	Moderate	0.312
Academic Burnout (AB)	0.319	Moderate	0.275
Academic Stress (AS)	0.111	Weak	0.098

Note. Note. R² values were interpreted using the PLS-SEM benchmarks proposed by Hair et al., (2022) weak ($R^2 \approx 0.25$), moderate ($R^2 \approx 0.50$), and substantial ($R^2 \approx 0.75$). $Q^2 > 0$ for all endogenous constructs confirms predictive relevance (Stone, 1974)

The research model explains 35.5% of the variance in students' mathematical problem-solving ability ($R^2 = 0.355$) and 31.9% of the variance in academic burnout ($R^2 = 0.319$). The positive Q² values across all endogenous variables (Problem-Solving Ability: $Q^2 = 0.312$) indicate adequate predictive

relevance. These results provide preliminary support for the model's out-of-sample predictive relevance, although this claim is based solely on blindfolding-derived Q^2 and would benefit from confirmation using PLSpredict in future analyses.

DISCUSSION

Before turning to substantive interpretation, several methodological factors warrant consideration. First, common method variance is a plausible concern given that all constructs were measured via a single self-report instrument at one point in time; the common method bias tests reported above suggest this is not a severe threat, but residual method effects cannot be fully ruled out. Second, the conceptual overlap between self-efficacy and the perceptually measured outcome ($HTMT = 0.548$, the highest among all construct pairs) means that part of the self-efficacy, ability association may reflect shared self-report variance rather than a substantive psychological effect. Third, the cross-sectional design does not support causal language; terms such as "predictor" and "association" are used throughout rather than "effect" or "determinant" in the causal sense. The findings of this study reveal a complex pattern of relationships among digital competence, academic stress, self-efficacy, and academic burnout in shaping students' mathematical problem-solving ability at Madrasah Aliyah. Digital competence showed a positive association with problem-solving ability ($\beta = 0.116$; $p < 0.01$), consistent with the findings of Simsek (2022). Students who are digitally proficient have more efficient access to learning resources and computational tools, enabling them to allocate greater cognitive capacity to mathematical conceptual understanding (Skulmowski & Xu, 2022). Nevertheless, digital competence did not prove effective in reducing academic stress ($\beta = 0.047$; $p = 0.465$) or academic burnout ($\beta = -0.084$; $p = 0.086$). This finding suggests that digital proficiency operates as an academic leverage mechanism rather than a stress-coping mechanism. Stress in mathematics is more deeply rooted in content complexity and intrinsic academic anxiety, meaning digital expertise alone is insufficient to alleviate it. This aligns with the observation by Ran et al. (2022) that the effect of technology on achievement is moderate and highly dependent on the pedagogical approach employed.

A compelling paradox emerged regarding the role of self-efficacy. It was confirmed as the most dominant direct predictor of perceived problem-solving ability ($\beta = 0.397$, $p < 0.001$), consistent with social cognitive theory, in which task-specific self-efficacy beliefs are shaped by mastery experience, vicarious experience, social persuasion, and physiological states (Usher & Pajares, 2008). This is further corroborated at the micro-classroom level, where students with high self-confidence have been shown to satisfy all indicators of mathematical communication and problem-solving ability, whereas those with low self-confidence fulfil only minimal indicators (Aulia et al., 2021). Self-efficacy unexpectedly increased academic stress ($\beta = 0.369$) and academic burnout ($\beta = 0.133$). This anomalous positive pathway suggests a 'dark side' of high self-belief within competitive educational settings. Students with high self-efficacy often harbor intense academic commitment and set highly ambitious targets, which inadvertently subjects them to severe self-imposed psychological tension and perfectionism (Widlund et al., 2023). In this specific context, strong self-efficacy acts as an internal driver that forces students to persist through overwhelming workloads, thereby amplifying their perceived stress and systemic burnout.

Academic stress was confirmed as the primary predictor of burnout ($\beta = 0.446$; $p < 0.001$). As corroborated by Almarzouki (2024) persistent stress continuously depletes students' working memory capacity, ultimately resulting in a state of cognitive exhaustion. This finding is consistent with Zhang et al. (2025), who describe the vicious cycle between stress and burnout. Notably, academic stress did not show a direct significant association with problem-solving ability ($\beta = 0.033$; $p = 0.336$), indicating that its association with ability may instead operate indirectly through academic burnout.

The most surprising empirical finding was the positive structural association between academic burnout and perceived problem-solving ability ($\beta = 0.184$, $p < 0.001$), which counters conventional assumptions about burnout as uniformly detrimental. This pattern was not merely an artefact of controlling for other predictors: the zero-order correlation between academic burnout and perceived problem-solving ability was also positive, $r = 0.346$, indicating that the association held even at the bivariate level and was not solely attributable to suppression by academic stress, although, as a

correlational pattern, it still warrants cautious interpretation. Because the School Burnout Inventory measures exhaustion, cynicism, and reduced efficacy rather than study effort directly, this pattern may indicate that burnout co-occurs with intensive academic engagement among some students, rather than that burnout itself improves ability. This interpretation is speculative, as the sample was not independently verified as "high-achieving," and should be tested directly in future research using objective effort or performance measures. This interpretation is supported by Madigan & Curran (2021), who affirm that burnout is negatively correlated with achievement only when it reaches the point of destructive burnout. So long as burnout remains within a productive corridor, students remain motivated and do not undergo *disengagement*. Burnout thus becomes an indicator of optimal learning effort (Kuokkanen et al., 2025).

When all four variables are analysed simultaneously, the model explains 35.5% of the variance in mathematical problem-solving ability ($R^2 = 0.355$). This indicates that psychological and digital factors collectively and meaningfully shape students' mathematical competence. The interactions among variables form two primary pathways towards problem-solving ability. The first is the capacity pathway: digital competence strengthens access and learning efficiency, while self-efficacy builds the persistence and cognitive strategies needed to resolve complex problems. The second is the pressure pathway: high self-efficacy triggers greater academic stress, which in turn induces burnout. This burnout, however, provided it remains productive, correlates positively with problem-solving ability.

The practical implication of these findings is the need for a holistic approach in educational policy. The development of digital competence must be accompanied by the strengthening of students' psychological dimensions, particularly productive stress management and burnout regulation. Academic guidance programmes should target the maintenance of students' self-efficacy while equipping them with effective self-regulation strategies, ensuring that academic stress does not escalate into burnout (Fauziyah et al., 2024). Beyond individual psychological factors, this study's findings align with a broader body of evidence demonstrating that affective dimensions including students' attitudes and engagement levels are significant predictors of learning outcomes across subjects (Ilhami et al., 2025). Educational interventions should therefore address not only digital skills but also the cultivation of positive academic dispositions.

These findings collectively indicate that single-domain interventions are insufficient for enhancing perceived mathematical problem-solving ability. Specifically, digital competence alone exerts only a modest direct association ($\beta = 0.116$), while self-efficacy, despite being the strongest predictor of perceived ability ($\beta = 0.397$), simultaneously elevates academic stress ($\beta = 0.369$) and academic burnout ($\beta = 0.133$). This suggests that fostering self-efficacy without equipping students with stress-regulation and recovery strategies may inadvertently heighten psychological vulnerability, particularly as self-efficacy beliefs are known to be reinforced by the emotional and physiological states students experience during challenging academic tasks (Usher & Pajares, 2008). Therefore, a holistic educational intervention that simultaneously develops digital skills, strengthens psychological resilience, and promotes healthy burnout management represents the most promising strategy for sustainable gains in mathematical problem-solving competence.

CONCLUSION

This study examined the association of self-efficacy, digital competence, and academic stress with Madrasah Aliyah students' perceived mathematical problem-solving ability in Jambi Province, Indonesia, and academic burnout as a mediating mechanism. Self-efficacy emerged as the strongest predictor of perceived ability ($\beta = 0.397$, $p < 0.001$); contrary to expectations, self-efficacy was also positively associated with academic stress ($\beta = 0.369$, $p < 0.001$) and academic burnout ($\beta = 0.133$, $p = 0.002$), and these two hypotheses (H1, H2) were therefore not supported in the predicted direction. Academic burnout showed an unexpected positive association with perceived ability ($\beta = 0.184$, $p < 0.001$; H9 also not supported in the predicted direction), a pattern discussed as tentative and possibly reflecting statistical suppression rather than a beneficial effect of burnout. Digital competence was positively associated with perceived problem-solving performance ($\beta = 0.116$, $p < 0.01$) but was not significantly related to academic stress or burnout. Academic stress was the strongest predictor of

burnout ($\beta = 0.446$, $p < 0.001$), while its direct association with perceived ability was non-significant, with evidence supporting an indirect pathway through burnout. Collectively, the model accounted for 35.5% of the variance in perceived mathematical problem-solving ability ($R^2 = 0.355$). Given the cross-sectional, self-report design, these findings should be read as associative rather than causal. They nonetheless suggest that educational policies pairing digital-literacy development with structured psychological support, particularly stress-regulation strategies for high-efficacy students, may be important for supporting students' mathematical competence.

This study has several limitations. First, the cross-sectional survey design precludes causal inference. Second, all constructs, including the outcome variable, relied on self-report measures collected at a single time point, raising the possibility of common method bias, although the tests reported above did not indicate a severe threat. Third, mathematical problem-solving ability was measured through perceptual self-report items rather than an objective performance test, which conceptually overlaps with self-efficacy; this is a central limitation of the present findings. Fourth, the sample was drawn from a single province and predominantly from state madrasah, and Grade XI was somewhat under-represented, which may limit generalisability. Finally, potential demographic moderators (e.g., gender, grade level, school type) were not tested. Future research should incorporate longitudinal or experimental designs, objective measures of mathematical performance, multi-source data to further rule out common method bias, and tests of demographic moderation.

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DECLARATIONS

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Additional Information	: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request, subject to permission from the participating Madrasah Aliyah.
Ethics Statement	: This study was conducted in accordance with ethical principles for research involving human participants. Permission to conduct the study was obtained from the relevant school authorities, and written informed consent was obtained from all participants and/or their legal guardians prior to data collection. Participants were informed of the voluntary nature of their participation, their right to withdraw at any time without penalty, and the confidentiality and anonymity of their responses, which were used solely for academic research purposes.

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