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Unpacking the Mechanism: Metacognitive Self-Evaluation in the Relationship Between Digital Self-Regulated Learning and Academic Performance

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Abstract

This study examines whether metacognitive self-evaluation statistically mediates the association between digital self-regulated learning (SRL) and academic performance among 577 undergraduate students in Jakarta, Indonesia. The analysis is a quantitative reanalysis of a publicly available, de-identified dataset collected in May–June 2023. Digital SRL was operationalised as the mean of 20 Online Self-Regulated Learning Questionnaire items across goal setting, environment structuring, task strategies, time management and help-seeking. Metacognitive self-evaluation was measured with the four-item OSLQ self-evaluation subscale, while academic performance was represented by a five-category ordered GPA index. HC3-robust regression and 10,000-resample bootstrap inference showed a positive association between SRL and self-evaluation ($B = 0.718$, $SE = 0.050$, $p < .001$; $R^2 = .347$). However, self-evaluation did not significantly predict the GPA index conditional on SRL ($B = 0.094$, $SE = 0.061$, $p = .121$), and the indirect effect was not statistically distinguishable from zero ($B = 0.068$, 95% bootstrap CI [−0.019, 0.153]). A covariate-adjusted indirect effect was also non-significant. An ordinal-logit sensitivity model produced a positive conditional association for self-evaluation ($OR = 1.49$, $p = .044$), but this result does not establish mediation. The findings distinguish strong interconnectedness among regulatory processes from an unconfirmed pathway to the available GPA measure.

Keywords: self-regulated learning; metacognitive self-evaluation; online learning; blended learning; academic performance; mediation; secondary data.

1. Introduction

Digital and blended learning require students to regulate a greater share of their learning activity independently. Students must decide when to study, structure their learning environment, select task strategies, allocate time and seek help when comprehension is insufficient. Social-cognitive accounts describe these behaviours as part of a cyclical process in which goals, monitoring and reflection guide subsequent action (Zimmerman, 2000, 2002). Research on online higher education likewise indicates that time management, metacognition and related strategies can be associated with academic performance, although their predictive value depends on the learning context and how achievement is measured (Broadbent & Poon, 2015; Broadbent, 2017).

A theoretical link between digital SRL and academic performance is plausible, but it should not be assumed that a broad SRL score necessarily predicts grades through a single pathway. Metacognitive self-evaluation may be one mechanism: learners review their understanding, judge whether a strategy worked and decide whether to modify their approach. Prior work has examined metacognitive strategy use in online learning and its relationship with learning performance (Anthonysamy, 2021), while research on university study strategies has highlighted the need to distinguish reported strategies from actual assessment outcomes (Zepeda & Nokes-Malach, 2021).

The present study tests this proposed mechanism with secondary data rather than treating mediation as established by theory alone. The data contain six OSLQ dimensions, including self-evaluation, and a cumulative GPA measure

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recorded in five ordered categories. Because self-evaluation is the available metacognitive proxy rather than a separate comprehensive metacognition inventory, the conclusions are deliberately limited to that operationalisation.

The study contributes in three ways. First, it estimates the indirect pathway using bootstrap inference. Second, it reports an ordinal-logit sensitivity analysis because GPA is categorical and strongly concentrated in the highest band. Third, it makes the non-significant mediation result central to interpretation rather than selecting only the model specification that produces a statistically significant coefficient.

2. Literature Review and Hypothesis Development

2.1 Digital SRL and academic performance

The OSLQ was developed to assess self-regulation in online and blended environments across multiple behavioural domains (Barnard et al., 2009). A systematic review of online higher education research identified time management, metacognition, effort regulation and critical thinking among the strategies associated with grade outcomes, while also noting that relationships differ across strategy types (Broadbent & Poon, 2015). A later comparison of online and blended learners found that the predictive value of individual strategies can vary by study mode, even where the broad pattern of grade predictors is similar (Broadbent, 2017). A meta-analysis of SRL training programmes reported positive average effects on academic performance and related strategies, although intervention effects do not imply that self-reported strategy scores must correlate strongly with grades in every observational sample (Theobald, 2021). These findings support testing the association in the present sample, but do not warrant assuming that all SRL dimensions have equal effects.

2.2 Metacognitive self-evaluation as a potential mechanism

Metacognition includes knowledge about cognition and the regulation of cognitive activity. Schraw and Dennison (1994) distinguished these broad components in their measure of metacognitive awareness. In the present study, the OSLQ self-evaluation subscale provides a narrower behavioural proxy: it captures students' reported reflective evaluation, not the full domain of metacognitive knowledge or regulation. Anthonysamy (2021) reported that metacognitive strategy use was relevant to online learning, and Zepeda and Nokes-Malach (2021) examined how reported study strategies related to examination performance. Together, these studies provide a rationale for testing the self-evaluation pathway while leaving its strength an empirical question.

2.3 Hypotheses

H1: Higher digital SRL is positively associated with metacognitive self-evaluation.

H2: Metacognitive self-evaluation is positively associated with academic performance after controlling for digital SRL.

H3: Metacognitive self-evaluation carries a positive indirect association between digital SRL and academic performance.

H4: Digital SRL has a positive direct association with academic performance after controlling for self-evaluation.

These hypotheses describe statistical relationships in a cross-sectional dataset. They do not imply temporal precedence or causal effects.

3. Methodology

3.1 Research design and data source

The study is a quantitative secondary-data analysis of the public dataset 'Data on undergraduate students' self-regulation in online and blended learning environments during the COVID-19 pandemic in Indonesia' (Irwanto, 2023).

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The dataset contains 577 usable responses from undergraduates at Universitas Negeri Jakarta. The original survey was administered online in May and June 2023 using an adapted 24-item OSLQ and demographic questions; the release is available under a CC BY 4.0 licence. The dataset's later publication as a data article is documented by Irwanto (2024). No new participants were recruited for the present analysis.

3.2 Measures and operationalisation

Digital SRL was computed as the mean of 20 OSLQ items drawn from goal setting (five items), environment structuring (four), task strategies (four), time management (three) and help-seeking (four). Self-evaluation was computed as the mean of its four OSLQ items and used as the proposed mediator. The available cumulative GPA variable was recoded into an ordered five-category index, with 1 representing below 2.0 and 5 representing 3.5 or above. Thus, a higher index value indicates a higher GPA category; it is not an exact continuous GPA score.

Table 1. Study variables and operationalisation

Construct	Items / source fields	Operationalisation	Analytical role
Digital SRL	GS1–GS5; ES1–ES4; TS1–TS4; TM1–TM3; HS1–HS4	Mean of 20 items on five-point response scales	Predictor composite
Metacognitive self-evaluation	SE1–SE4	Mean of four self-evaluation items	Proposed mediator
Academic performance	Cumulative GPA category	Ordered index: 1 = below 2.0; 5 = 3.5+	Outcome
Covariates	Gender, academic year, age group, daily Internet usage	Original coded categories	Adjusted sensitivity model

Source: Authors' operationalisation of the Irwanto (2023) dataset; OSLQ domains described by Barnard et al. (2009).

3.3 Statistical analysis

Descriptive statistics and Cronbach's alpha were calculated for the OSLQ subscales and the five-domain SRL composite. Pearson correlations were used to summarise bivariate associations. The primary mediation model estimated the a, b, c and c′ regression paths using heteroskedasticity-consistent HC3 standard errors. The indirect effect was evaluated with 10,000 non-parametric bootstrap resamples. A second mediation specification adjusted for gender, academic year, age group and daily Internet usage. Because GPA is ordinal and heavily concentrated in the top category, ordered-logit models were used as a sensitivity analysis. The ordinal models are treated as a separate scale-appropriate robustness check, not as a substitute for the linear mediation estimate.

Statistical significance was assessed at $p < .05$. The mediation conclusion was based primarily on the bootstrap confidence interval for the indirect effect rather than on the separate significance tests for the component paths (Hayes, 2018).

4. Results

4.1 Sample profile

The analytic sample comprised 577 students. Women represented 75.0% of the sample, and first-year students were the largest academic-year group (49.0%). Most respondents were aged 18–20 years (74.5%). The GPA distribution was highly concentrated in the highest category: 410 respondents (71.1%) reported GPA 3.5 or above, while only 33 respondents (5.7%) were below 3.0.

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Table 2. Composition of the analytic sample (N = 577)

Indicator	Distribution: n (%)
Gender	Female: 433 (75.0%); male: 144 (25.0%)
Academic year	First year: 283 (49.0%); second year: 163 (28.2%); third year: 89 (15.4%); fourth year: 42 (7.3%)
Age group	18–20 years: 430 (74.5%); 21–23 years: 142 (24.6%); above 23 years: 5 (0.9%)
GPA category	3.5+: 410 (71.1%); 3.0–3.49: 134 (23.2%); 2.5–2.99: 26 (4.5%); 2.0–2.49: 4 (0.7%); below 2.0: 3 (0.5%)

Source: Authors' analysis of the Irwanto (2023) secondary dataset. Percentages may not sum to 100.0 because of rounding.

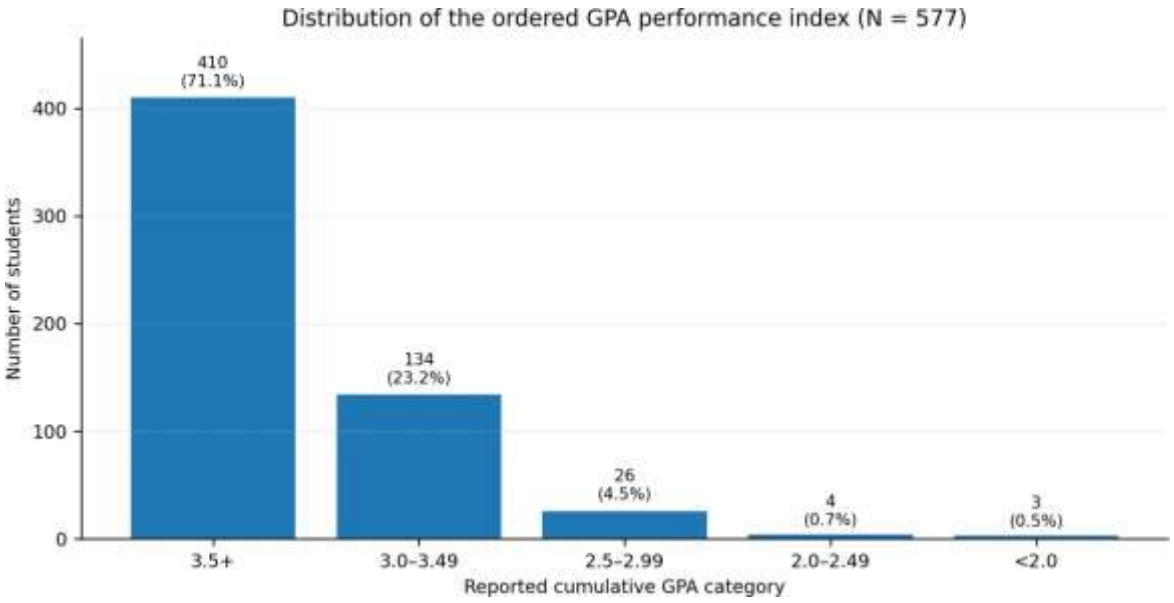


Figure 1. Distribution of reported cumulative GPA categories (N = 577).
Source: Authors' reanalysis of Irwanto (2023), Mendeley Data, DOI: 10.17632/7bsvck73ng.1. Bars show category counts; labels report percentages rounded to one decimal place.

4.2 Descriptive statistics and reliability

Table 3. Descriptive statistics and internal consistency

Scale	Mean	SD	Cronbach's α
Goal setting	3.938	0.541	0.672
Environment structuring	4.182	0.551	0.655
Task strategies	3.306	0.659	0.630
Time management	3.632	0.717	0.729
Help-seeking	3.647	0.670	0.591
Self-evaluation	3.992	0.556	0.660
Five-domain digital SRL composite	3.741	0.456	0.844

Source: Authors' analysis of the Irwanto (2023) dataset. The five-domain SRL composite excludes the self-evaluation mediator.

Environment structuring had the highest mean (M = 4.182), whereas task strategies had the lowest mean (M = 3.306). The five-domain composite showed good internal consistency in this sample (α = .844). Reliability estimates for the

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individual subscales varied, with help-seeking at α = .591 and self-evaluation at α = .660. These values counsel against treating the subscales as error-free measures (Taber, 2018).

4.3 Correlation analysis

Table 4. Pearson correlation matrix

Variable	GS	ES	TS	TM	HS	SE	Perf.
Goal setting	1.000	.351	.476	.586	.324	.414	.126
Environment structuring	.351	1.000	.287	.281	.287	.352	.109
Task strategies	.476	.287	1.000	.597	.443	.449	.027
Time management	.586	.281	.597	1.000	.383	.447	.009
Help-seeking	.324	.287	.443	.383	1.000	.462	−.018
Self-evaluation	.414	.352	.449	.447	.462	1.000	.089
Performance	.126	.109	.027	.009	−.018	.089	1.000

Source: Authors' analysis of the Irwanto (2023) dataset. GS = goal setting; ES = environment structuring; TS = task strategies; TM = time management; HS = help-seeking; SE = self-evaluation; Perf. = ordered GPA performance index.

Self-evaluation showed positive bivariate correlations with each SRL dimension (r = .352 to .462), consistent with the premise that reflective evaluation is integrated with learners' reported regulation strategies. The correlations between the individual SRL dimensions and the ordered GPA performance index were small in magnitude (r = −.018 to .126), foreshadowing the comparatively weak outcome relationships in the multivariable models.

4.4 Mediation analysis

Table 5. Primary regression-based mediation results

Path	Relationship	B	SE	p	Inference
a	Digital SRL → self-evaluation	.718	.050	< .001	Supported
b	Self-evaluation → performance | SRL	.094	.061	.121	Not supported
c′	Digital SRL → performance | self-evaluation	.020	.082	.804	Not supported
c	Total Digital SRL → performance	.088	.068	.198	Not supported
a × b	Indirect effect	.068	—	—	95% bootstrap CI [−.019, .153]

Source: HC3-robust regression estimates reported in the supplied analysis; the indirect-effect interval is based on 10,000 bootstrap resamples. B values are unstandardised.

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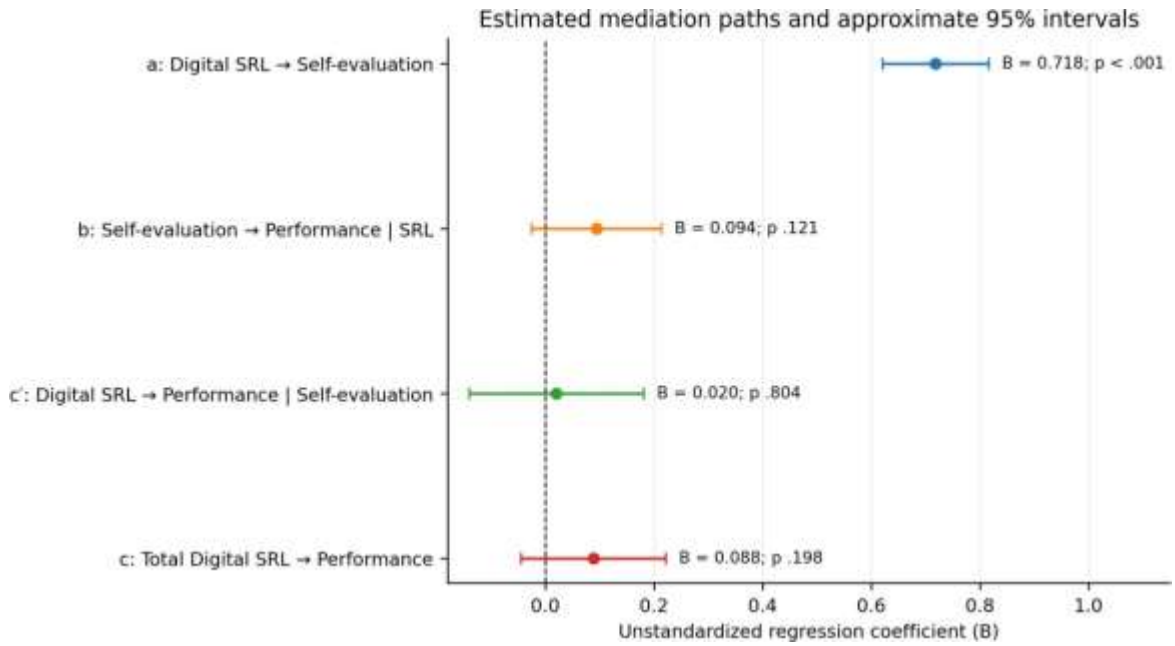


Figure 2. Estimated mediation-path coefficients with approximate 95% intervals.

Source: Authors' analysis using the reported HC3 regression coefficients and standard errors from Irwanto (2023). Error bars are normal-approximation intervals, B ± 1.96 × SE; the indirect effect is assessed separately using the reported bootstrap interval.

The a path was positive and statistically significant: students reporting stronger digital SRL also reported stronger self-evaluation (B = 0.718, SE = 0.050, p < .001). However, the b path did not reach significance when SRL was controlled (B = 0.094, p = .121). Neither the direct effect (c′ = 0.020, p = .804) nor the total effect (c = 0.088, p = .198) was significant. The bootstrap confidence interval for the indirect effect crossed zero, so H3 is not supported in the primary model. The pattern is therefore not evidence of a statistically reliable mediation mechanism.

4.5 Sensitivity analysis

Table 6. Sensitivity and robustness results

Specification	Reported estimate	Interpretation
Covariate-adjusted mediation	Indirect effect = .039; 95% CI [−.046, .125]	Not supported
Ordered logit: SRL only	OR = 1.37; p = .121	SRL composite not significant
Ordered logit: SRL + self-evaluation	SRL OR = 1.03; p = .910; self-evaluation OR = 1.49; p = .044	Conditional association for self-evaluation only

Source: Authors' analysis as reported in the supplied manuscript. The ordinal-logit model is a separate sensitivity analysis and does not establish mediation.

Adjustment for the demographic and Internet-use covariates did not produce a supported indirect effect. In the ordered-logit model including SRL and self-evaluation, self-evaluation was associated with higher odds of being in a higher GPA category (OR = 1.49, p = .044), while the SRL composite was not (OR = 1.03, p = .910). This conditional association should be interpreted cautiously: it arises under an alternative outcome model and does not overturn the non-significant bootstrap mediation result.

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5. Discussion

The clearest result is the substantial association between digital SRL and self-evaluation. That result is compatible with social-cognitive models in which planning, strategy choice, monitoring and reflection form an interconnected regulatory cycle (Zimmerman, 2000, 2002). It also accords with online-learning literature that treats metacognitive activity as relevant to the learning process (Anthonysamy, 2021). Nevertheless, the central mediation hypothesis was not supported. Once the overall SRL composite was included, self-evaluation did not significantly predict the GPA index in the primary linear model, and the indirect-effect confidence interval included zero.

The ordinal-logit sensitivity result is informative but should not be selectively promoted as the preferred finding. GPA is an ordered category rather than an exact numerical score, and 71.1% of respondents were in the top category. This concentration reduces outcome variation and makes it difficult to differentiate predictors. The ordinal model indicates that the relationship between self-evaluation and performance can look different under an outcome-appropriate link function, but it does not establish that self-evaluation carries an effect from SRL to grades. Different estimands and link functions answer related, not identical, questions.

Measurement also matters. The self-evaluation subscale had modest internal consistency ($\alpha = .660$), and it is a limited proxy for metacognitive regulation. A more comprehensive instrument may capture monitoring accuracy, calibration, and strategic adaptation more directly. The broad SRL composite itself has satisfactory internal consistency ($\alpha = .844$), but averaging five domains can conceal potentially different associations. Future research should compare prespecified dimension-level and composite models in a transparent analytical plan.

6. Practical Implications

Educators can support goal setting, time planning, learning-space organisation, strategy selection and reflective prompts within digital courses. Such practices are justified as supports for learners' regulation processes, not as a guaranteed route to higher GPA. Course designers should combine SRL prompts with timely feedback, opportunities to seek help and assessments that reveal understanding. For programme evaluation, institutions should assess whether these supports improve learning behaviours and objective achievement rather than relying on self-reports alone.

7. Limitations and Future Research

The study is cross-sectional and based on a single institution; associations cannot establish temporal order or causation. Recruitment in the source study used purposive and snowball approaches, limiting population generalisation. The outcome is a self-reported ordered GPA category, heavily concentrated at the top, rather than verified continuous academic records. The metacognitive construct is represented by the OSLQ self-evaluation subscale, and its reliability is moderate. Future studies should combine repeated measurements, a dedicated metacognition instrument, learning-platform activity and verified assessment records. Ordinal mediation or categorical-data SEM would also be useful for testing indirect effects without treating the GPA categories as equally spaced.

8. Conclusion

This secondary-data reanalysis found that digital SRL was strongly associated with metacognitive self-evaluation, but it did not find statistical support for the proposed indirect pathway to the ordered GPA performance index. A positive conditional association between self-evaluation and GPA emerged in one ordinal sensitivity model, yet this was not equivalent to a supported mediation effect. The principal conclusion is therefore qualified: SRL and self-evaluation are closely related in students' reports, but their connection to academic performance remains uncertain with this measure and sample.

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9. Data Availability and Research Integrity

The de-identified dataset is publicly available from Mendeley Data under DOI 10.17632/7bsvck73ng.1 and a CC BY 4.0 licence (Irwanto, 2023). The source data article describes voluntary participation and removal of personal identifiers (Irwanto, 2024). This manuscript reports a secondary analysis and did not recruit participants. The analysis is observational and does not support causal claims.

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