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The Role Of Self-Regulated Learning In Mediating Competence And Digital Literacy On Teacher Performance

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Abstract

Teacher professional development is often framed as adding competencies, even though strengthening technical capacity does not automatically improve teaching performance. This study examines self-regulated learning (SRL) as a mediating pathway linking industry-based professional competence and digital literacy to teacher performance. An explanatory, cross-sectional quantitative approach surveyed all 168 productive-subject teachers at six State Vocational High Schools in Situbondo Regency using a census technique, achieving a 100% response rate. Data were collected with a closed-ended, 1–5 Likert-scale questionnaire comprising 42 items (41 after one item was removed) and analyzed using Partial Least Squares Structural Equation Modeling in SmartPLS 4. Industry-based professional competence and digital literacy were positively and significantly associated with teacher performance and with SRL, and SRL was positively and significantly associated with teacher performance. SRL partially mediated the relationships of both exogenous variables with teacher performance, with the path from industry-based competence to SRL being strongest. The model explains 27.8% of the variance in SRL and 37.3% of the variance in teacher performance, with moderate predictive relevance. Because all constructs were self-reported at a single time point, the findings describe modeled relationships among teachers' reported perceptions, not causal effects or independently observed performance. The results suggest that self-regulation capacity may be an important pathway through which competence resources relate to performance. Professional development programs may therefore consider strengthening self-directed learning ability alongside competence transfer, for example through protected self-development time and mentoring in setting individual competence targets, an idea that requires testing in longitudinal or experimental designs.

Keywords: teacher performance, industry-based professional competence, digital literacy, teacher professional development, self-regulated learning

Introduction

Teacher performance ultimately determines the quality of classroom learning. A synthesis of more than two thousand meta-analyses shows that variables within teachers' control, such as the clarity of material delivery and the quality of feedback, contribute far more to learning

outcomes than structural variables like class size or school status (Hattie, 2023), making teacher professional development the most strategic lever for improving educational quality. Yet most development programs still rest on a linear assumption: that adding competence automatically improves performance. This leaves a black box, since teachers who complete training and master new tools do not always translate that mastery into changed classroom practice, in part because competence and performance are still often treated as identical constructs rather than causally linked (Aindra et al., 2022).

Recent studies have tried to fill this gap by examining intervening variables: motivation and professional development (Kholifah et al., 2024), and, at the organizational level, transformational and situational leadership, knowledge management, organizational culture, and self-efficacy (Firmansyah et al., 2022; Huda et al., 2025). In the digital domain, digital literacy has been linked to vocational teacher performance (Dharma, 2022; Cattaneo et al., 2022), though DigCompEdu-based mapping still shows an uneven distribution of educators' competence, particularly in the pedagogical and technical problem-solving dimensions (Antonietti et al., 2022; Arimbawa et al., 2024; Ningsih & Akhyar, 2024; Redecker & Punie, 2017). Building on this, school-industry partnerships (Huo & Zhang, 2025; Zhang et al., 2022), structured internships (Akhyar et al., 2024; Herawati et al., 2021), and upskilling and reskilling programs (Siagian, 2023) have been shown to enrich teachers' technical capital.

A different line of research positions self-directed learning ability as the core of professionalism. Self-regulated learning is understood as a three-phase cycle of planning, performance monitoring, and self-reflection (Zimmerman, 2002; Greenquist-Marlett et al., 2025), rooted in individuals' agentic capacity to direct their own behavior through standard-setting and self-evaluation (Bandura, 1991; Täschner et al., 2025; Woreta et al., 2025). Structured interventions foster this capacity in vocational settings (Mejeh & Held, 2022; Mejeh & Grieder, 2025), a technology-assisted SRL framework has been developed for vocational high school teachers (Shyr et al., 2025), and research on teachers' professional competences in SRL shows that teachers act both as self-regulated learners and as agents who promote SRL in students (Karlen et al., 2023, 2024), while a professional development program targeting these competences showed mixed effects (Hirt et al., 2025). A three-level meta-analysis of 31 quantitative studies reports a moderate positive correlation between digital literacy and SRL ($r = .37$), moderated by how the constructs are defined and measured and by participant and geographic characteristics (Lan et al., 2025), and in the Indonesian context both have been tested together as determinants of learning quality (Arma, 2024). The professional capital perspective unites both lines of research by viewing teacher capacity as an accumulation of human, social, and decisional capital built through directed experience (Hargreaves & Fullan, 2012; Zhang et al., 2025).

A research gap emerges at the intersection of these two lines of inquiry. Studies on teacher competence generally stop at acquisition and rarely examine how competence is carried into performance (research on industry work placement for vocational teachers, for example, has mainly examined the motivational beliefs behind their engagement; Zhou et al., 2024), while studies on self-regulation more often treat SRL as a training outcome rather than as a mediating variable within the teacher. Broader studies on teaching effectiveness remain dominated by mapping dimensions and educator readiness without testing a complete mediating pathway

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(Arias-Pastor et al., 2023; Mastrokoukou et al., 2022), although teachers' own self-regulation has been linked to how they teach (Karlen et al., 2023). To the author's knowledge, few studies have tested, in one integrated model, the relationships of industry-based competence and digital literacy with teaching performance through SRL as a mediating variable.

The expectation that SRL mediates these relationships follows from social cognitive theory, in which capabilities shape performance through self-regulatory processes of standard-setting, self-monitoring, and self-evaluation (Bandura, 1991) that unfold in the forethought, performance, and self-reflection phases of Zimmerman's (2002) cycle. Two mechanisms are proposed. First, industry-based competence is expected to give teachers concrete reference points for judging their own practice, such as workplace standards, task requirements, and feedback from industry partners, which make goal-setting, monitoring, and reflection easier to carry out; work placements are also occasions for teachers' own learning, and engagement in them is related to teachers' motivational beliefs (Zhou et al., 2024), and industrial internship experience is related to the teaching readiness of vocational teachers alongside their self-efficacy (Akhyar et al., 2024). Second, digital literacy is expected to give teachers tools for finding information, tracking progress, and revising their approach, and the wider literature reports a moderate positive correlation between digital literacy and SRL (Lan et al., 2025). In both cases, teachers who regulate their own learning are expected to turn what they know into practice more deliberately, in line with evidence that teachers' own SRL skills are linked to their promotion of metacognition in class through self-efficacy and interest (Karlen et al., 2023). A direct path from each resource to performance is retained, because competence and literacy can also be applied without deliberate self-regulation. Because the evidence is correlational and the digital literacy–SRL relationship may run in both directions, the model tests statistical mediation in cross-sectional data, not a causal process.

This study therefore tests whether SRL mediates the associations of industry-based professional competence and digital literacy with teacher performance among vocational teachers. The hypotheses are that competence and digital literacy are positively associated with teacher performance (H1, H2) and with SRL (H3, H4), that SRL is positively associated with teacher performance (H5), and that SRL mediates the association of competence (H6) and of digital literacy (H7) with teacher performance. The study contributes theoretically by examining SRL as a mediating variable for two distinct sources of professional capital in one model, empirically by measuring competence through contextual indicators (structured internship frequency and Teaching Factory involvement) in a census of vocational teachers in one regency, and practically by indicating whether professional development focused on competence alone may suffice or should also support teachers' self-regulation, a question the cross-sectional data can inform only tentatively.

Method

This study used a quantitative explanatory, cross-sectional design to test the seven hypotheses (H1–H7) stated at the end of the Introduction. Because all data were collected at a single time point, the model estimates associations and indirect relationships; the word "effect" is used in the PLS-SEM sense of a modeled path and implies neither temporal order nor causation.

The study was conducted in 2026 at six State Vocational High Schools in Situbondo Regency, East Java (SMKN 1 Suboh, SMKN 1 Kendit, SMKN 1 Situbondo, SMKN 2 Situbondo,

SMKN 1 Panji, and SMKN 1 Banyuputih), which house five expertise clusters: engineering and technology, business and management, tourism and creative crafts, agribusiness, and health and maritime studies. The population comprised all 168 productive-subject teachers active in the 2025/2026 academic year according to Dapodik records, and a census was used because the population was small and fully accessible. Eligible teachers were civil servants (PNS), contract government employees (PPPK), or temporary teachers (GTT) who teach at least one subject in the vocational subject group of Permendikdasmen No. 13 of 2025 (Kementerian Pendidikan Dasar dan Menengah, 2025), referred to here as productive-subject teachers; teachers on extended leave or with incomplete questionnaires were excluded. All 168 questionnaires were returned complete, a 100% response rate.

Data were collected through an online five-point Likert-scale questionnaire distributed as a Google Form link via teachers' WhatsApp groups and official letters to the six principals, after permission from the district education office branch. To reduce socially desirable responding and common method bias, the instructions stated that there were no right or wrong answers, confidentiality of identity and answers was guaranteed, and respondents were told that their answers were unrelated to official performance appraisal. The four constructs were presented in separate, fixed-order sections, and the identity section included a name field, so responses were confidential but not fully anonymous. Because all constructs, including teacher performance, were reported by the same respondents in one survey, the study measures teachers' perceptions and not independently observed performance.

The instrument consisted of 42 statement items written in Indonesian for productive-subject teachers. The items were not taken from a single validated scale; they were developed by operationalizing established frameworks and prior studies, with each indicator mapped to its conceptual source: competence to Huo and Zhang (2025), Zhang et al. (2022), and Hargreaves and Fullan (2012); digital literacy to the DigCompEdu framework (Redecker & Punie, 2017); SRL to the three-phase model of Zimmerman (2002), operationalized one-to-one by the author; and teacher performance to Yeo (2024), Mastrokoukou et al. (2022), and Kholifah et al. (2024). Because several sources are English-language, the author formulated and contextualized the items, with no formal back-translation reported. No separate pilot test or formal expert content-validity review was conducted; validity and reliability were assessed on the full sample (see Results), which is acknowledged as a limitation. The items covered the indicators of each construct: 12 for competence, 9 for digital literacy, 9 for SRL, and 12 for teacher performance. One competence item, participation in industry certification tests (X1.4.3), was removed after the measurement model evaluation (see Results). It was the third item of the fourth indicator, which remains represented by two items on internship experience and school-industry collaboration; the final construct therefore no longer captures formal certification-based recognition and reflects practical competence and industrial engagement more than formally credentialed competence, which narrows its content coverage and is treated as a limitation.

Data were analyzed in two stages using PLS-SEM in SmartPLS 4, chosen for estimating complex latent models and testing mediation (Hair et al., 2019). The measurement model was evaluated through outer loading, average variance extracted, Cronbach's alpha, composite reliability, indicator-level variance inflation factor (VIF) values to detect redundant items, the Fornell–Larcker criterion, cross-loadings, and the heterotrait-monotrait ratio (HTMT) with a threshold below 0.90 (Hair et al., 2022). The structural model was evaluated through the

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coefficient of determination, effect size, predictive relevance, and the variance inflation factor, which was also used as a full-collinearity diagnostic for common method bias (Kock, 2015). Hypotheses were tested with 5,000 bootstrap subsamples (t-statistic above 1.96 and p-value below 0.05 in the hypothesized direction), with percentile bootstrap 95% confidence intervals for the indirect effects; partial mediation was indicated by a variance accounted for between 20% and 80%.

Results

Respondent Characteristics and Empirical Condition of the Variables

The distribution of respondents was relatively balanced by gender, with 88 female teachers (52.4%) and 80 male teachers (47.6%). Most respondents were of mature age, with 67 people (39.9%) aged 30 to 40 years and 66 people (39.3%) aged 41 to 50 years, while 85.7% held a bachelor's degree as their highest education and 90.5% had more than five years of work experience. These figures suggest that respondents were educators well established in both qualifications and experience, suggesting that respondents were experienced educators, although their answers remain self-reports of perceived competence, digital literacy, learning regulation, and performance.

Descriptively, teacher performance obtained the highest mean score of 4.241, in the very high category, followed by self-regulated learning at 4.080 and industry-based professional competence at 4.016, both in the high category, while digital literacy obtained the lowest score of 3.749, although still in the high category. At the item level, the item on participation in certification tests recorded the lowest score among all research items, while the item on independently resolving technical problems was the weakest item on digital literacy. Teachers' engagement with the industrial world thus appears to take mostly the form of informal collaboration rather than formal competence recognition, while their digital proficiency remains stronger at the operational level than at the level of independence in handling technical problems.

Measurement Model Evaluation

The initial estimation showed that all outer loadings were above 0.70, except for the certification test participation item on the industry-based professional competence construct, which only reached 0.489. This item was eliminated and the model was re-estimated, resulting in a final model comprising 41 indicators with the path structure shown in Figure 1. Removing this item narrows the construct's coverage of formal certification-based recognition (see Method).

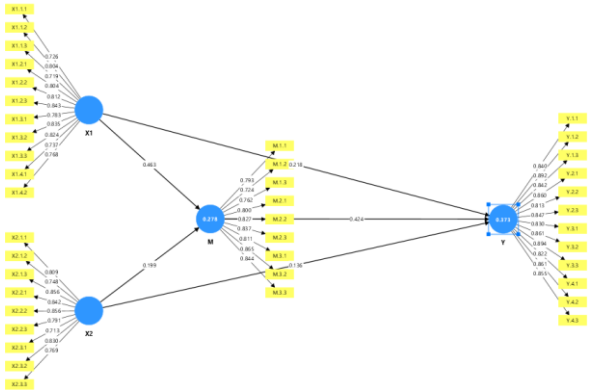


Figure 1. Final Structural Model from PLS Algorithm Estimation (After Indicator Elimination)

Based on Figure 1, the final model shows an R-Square value of 0.278 for self-regulated learning and 0.373 for teacher performance, with path coefficients consistent with the hypothesis testing results reported in Tables 4 and 5. After elimination, all indicators had outer loadings ranging from 0.713 to 0.894, meaning convergent validity at the indicator level was satisfied. The results of the construct reliability and average variance extracted tests are presented in Table 1.

Table 1. Results of Construct Reliability and Convergent Validity Testing

Variable	Cronbach's Alpha	Composite Reliability	AVE
Industry-Based Professional Competence	0.939	0.947	0.621
Digital Literacy	0.931	0.942	0.645
Self-Regulated Learning	0.933	0.944	0.653
Teacher Performance	0.966	0.969	0.725

Table 1 shows that all Cronbach's alpha and composite reliability values were above 0.90 and all average variance extracted values exceeded 0.50, so the instrument was declared reliable and convergent validity was satisfied at the construct level. Discriminant validity was also satisfied on all three criteria. The square root of each construct's AVE exceeded its correlations with the other constructs (Fornell–Larcker criterion; Table 2), all heterotrait-monotrait ratio values were below the threshold of 0.90, with the highest value of 0.583 found in the relationship between teacher performance and self-regulated learning (Hair et al., 2022), and every indicator loaded highest on its own construct in the cross-loading assessment (these results are available from the author upon request).

Table 2. Discriminant Validity: Fornell–Larcker Criterion (Above Diagonal) and HTMT (Below Diagonal)

Construct	Competence	Digital Literacy	SRL	Teacher Performance
Competence	0.788	0.131	0.489	0.443
Digital Literacy	0.146	0.803	0.260	0.275
SRL	0.515	0.272	0.808	0.566
Teacher Performance	0.456	0.280	0.583	0.852

Teacher performance showed very high reliability (α = 0.966; CR = 0.969), and two of its indicators, Y.1.2 and Y.3.3, had indicator-level VIF values of 5.661 and 5.270, slightly above 5 but well below 10. This suggests some content overlap among the performance items, which is plausible for reflective indicators of one construct rated by the same respondents; the HTMT values of this construct with all other constructs remained well below 0.90, so discriminant

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validity was not affected, and the item overlap is acknowledged as a limitation. Variance inflation factor values in the structural model ranged from 1.017 to 1.385, well below the full-collinearity threshold of 3.3 (Kock, 2015); the path coefficient estimates can therefore be interpreted without risk of bias from excessive correlation among predictors, and this diagnostic gives no sign of pronounced common method bias. A VIF-based test cannot, however, establish that such bias is absent, particularly because all constructs, including teacher performance, were measured with the same self-report questionnaire at one time point. The risk is therefore addressed through the procedural steps described in the Method section and is acknowledged as a limitation.

Structural Model Evaluation

The model's ability to explain and predict the endogenous variables is shown through the coefficient of determination and predictive relevance values in Table 3.

Table 3. Coefficient of Determination and Predictive Relevance

Endogenous Variable	R^2	Adjusted R^2	Q^2 Predict	Category
Self-Regulated Learning	0.278	0.269	0.238	Weak to moderate
Teacher Performance	0.373	0.362	0.204	Moderate

Table 3 indicates that industry-based professional competence and digital literacy together explain 27.8% of the variance in self-regulated learning, while the three predictor variables explain 37.3% of the variance in teacher performance. Both predictive relevance values are above zero in the moderate category, indicating that the model has adequate predictive power. By conventional benchmarks for R^2 (0.19 weak, 0.33 moderate, 0.67 substantial; Chin, 1998), the coefficient of determination values, classified as weak to moderate, at the same time confirm that teacher performance is a multi-determined construct, as shown by other studies identifying school leadership, organizational culture, and self-efficacy as additional explanatory factors (Firmansyah et al., 2022; Huda et al., 2025).

The results of testing the five direct-effect paths along with their effect sizes are presented in Table 4.

Table 4. Results of Direct Path Testing

Path	Coefficient	t-statistic	p-value	f^2	Decision
Competence → Teacher Performance	0.218	2.707	0.007	0.058	Accepted
Digital Literacy → Teacher Performance	0.136	2.250	0.025	0.028	Accepted
Competence → SRL	0.463	6.272	0.000	0.292	Accepted
Digital Literacy → SRL	0.199	2.783	0.005	0.054	Accepted
SRL → Teacher Performance	0.424	5.031	0.000	0.207	Accepted

Table 4 reports that all direct paths were significant at the 5% level. The strongest path is the path from industry-based professional competence to self-regulated learning, followed by the path from self-regulated learning to teacher performance, while the direct path from digital literacy to teacher performance is the weakest. This configuration is important to read as a whole: by conventional benchmarks ($f^2 \geq 0.02$ small, ≥ 0.15 medium, ≥ 0.35 large; Cohen, 1988), the two paths involving self-regulated learning ($f^2 = 0.292$ and 0.207) fall in the medium-to-large range and are in fact the largest in the model, whereas the direct paths from both sources of professional capital to performance ($f^2 = 0.058$ and 0.028) are small.

The results of testing the two indirect-effect paths, along with 95% bootstrap confidence intervals, and the proportion of the effect explained by the mediator,are presented in Table 5.

Table 5. Results of Indirect Path Testing

Path	Coefficient	t-statistic	p-value	VAF	Type of Mediation	95% CI
Competence → SRL → Teacher Performance	0.196	3.564	0.000	47.3%	Partial	[0.115, 0.330]
Digital Literacy → SRL → Teacher Performance	0.084	2.193	0.028	38.2%	Partial	[0.025, 0.175]

Table 5 shows that both indirect effects are statistically significant, with percentile bootstrap 95% confidence intervals of [0.115, 0.330] for H6 and [0.025, 0.175] for H7, neither of which includes zero. The mediator accounts for 47.3% of the industry-based competence path and 38.2% of the digital literacy path. Because both direct paths remained significant after the mediator was included and both proportions fall within the 20% to 80% range, the mediation is partial and complementary in nature (Hair et al., 2019). These indirect effects describe modeled relationships in cross-sectional, self-reported data; they do not establish temporal ordering or causal transmission through SRL. School teaching-assignment decrees show that 14 of the 168 respondents teach mainly general subjects alongside a vocational subject; excluding them (n = 154) changed the path coefficients by at most 0.034 and left the conclusions unchanged.

Further Exploratory Analysis: Multigroup Analysis and Importance-Performance Map Analysis

To follow up on the main model, two additional analyses were conducted on the same data: multigroup analysis (MGA) to test the stability of path coefficients across work-tenure groups and expertise clusters, and importance-performance map analysis (IPMA) to translate the association of each construct with teacher performance into intervention priorities. Both analyses were calculated using composite indicator scores (after elimination of item X1.4.3), validated to produce path coefficients very close to the original PLS estimates, with between-group difference testing using a 3,000-permutation procedure as an approximation of PLS-MGA. This composite-score approach was chosen over SmartPLS's built-in MGA and IPMA modules because the smallest subgroup in this analysis (the under-5-year tenure group, n = 16) is too small to support stable estimation of a full latent-variable model for each subgroup, making the composite-score

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procedure less sensitive to the small-sample instability that affects full latent-variable estimation at these subgroup sizes. This approach is exploratory in nature and is intended to complement, not replace, further verification through SmartPLS's built-in MGA and IPMA modules. All multigroup results should be read as exploratory: the subgroups are small, a liberal threshold of $p < 0.10$ was used, and each analysis involved 30 path-by-group-pair comparisons (five paths across six pairs of groups) so some differences flagged as significant may arise by chance; Benjamini–Hochberg adjusted values (Benjamini & Hochberg, 1995) are therefore reported alongside the unadjusted ones.

Path coefficients for each teaching-tenure group are reported in Table 6, with the corresponding between-group significance tests presented in Table 7.

Table 6. Path Coefficients by Teaching Tenure Group

Path	< 5 yrs (n=16)	5–10 yrs (n=42)	11–20 yrs (n=73)	> 20 yrs (n=37)
Competence → SRL	0.683	0.403	0.520	0.212
Digital Literacy → SRL	-0.417	0.223	0.368	0.159
Competence → Teacher Performance	0.840	0.088	0.110	0.215
Digital Literacy → Teacher Performance	-0.113	-0.037	-0.065	0.255
SRL → Teacher Performance	-0.261	0.690	0.772	0.139

Table 7. Results of Between-Group Path Difference Testing by Tenure Group ($p < 0.10$)

Groups Compared	Path	Δβ	p-value
< 5 yrs vs 5–10 yrs	Digital Literacy → SRL	-0.640	0.048
< 5 yrs vs 5–10 yrs	Competence → Teacher Performance	0.752	0.012
< 5 yrs vs 5–10 yrs	SRL → Teacher Performance	-0.951	0.004
< 5 yrs vs 11–20 yrs	Digital Literacy → SRL	-0.785	0.006
< 5 yrs vs 11–20 yrs	Competence → Teacher Performance	0.730	0.013
< 5 yrs vs 11–20 yrs	SRL → Teacher Performance	-1.034	0.001
< 5 yrs vs > 20 yrs	Digital Literacy → SRL	-0.576	0.083
< 5 yrs vs > 20 yrs	Competence → Teacher Performance	0.625	0.059

< 5 yrs vs > 20 yrs	Digital Literacy → Teacher Performance	-0.368	0.098
5–10 yrs vs > 20 yrs	Digital Literacy → Teacher Performance	-0.292	0.096
5–10 yrs vs > 20 yrs	SRL → Teacher Performance	0.551	0.031
11–20 yrs vs > 20 yrs	Digital Literacy → Teacher Performance	-0.320	0.062
11–20 yrs vs > 20 yrs	SRL → Teacher Performance	0.634	0.006

Tables 6 and 7 suggest, tentatively, that the path from self-regulated learning to teacher performance differs across work tenure: it is stronger in the two mid-career groups (5–10 and 11–20 years), weaker beyond 20 years of tenure, and negative among teachers with less than five years of tenure, with differences from the mid-career groups significant at $p < 0.05$. The tenure group of less than five years comprised only 16 respondents, so its estimates are statistically unstable and should be read as tentative rather than conclusive; the reversed direction in particular may reflect sampling variability. One possible reading, which these data cannot test, is that because self-regulation is itself a developing skill, goal-setting and self-monitoring efforts in the earliest career stage may be effortful and imperfectly calibrated, consistent with the view of self-regulation as a cycle that matures through repeated practice (Zimmerman, 2002). After Benjamini–Hochberg adjustment across the 30 comparisons, six of the 13 differences remain below $q = 0.10$: five involve the group with less than five years of tenure and one compares the 11–20 year group with the group beyond 20 years on the SRL to teacher performance path.

The corresponding path coefficients by expertise cluster are reported in Table 8, with the between-group significance tests presented in Table 9. Respondents were assigned to clusters according to the subject they actually teach, using the teaching-assignment decrees of the six schools and the grouping of vocational subjects in Permendikdasmen No. 13 of 2025 (Kementerian Pendidikan Dasar dan Menengah, 2025), and not the label written in the questionnaire. Concentration and program subjects were mapped to Engineering & Technology, Business & Management, Tourism & Creative Crafts, or Agribusiness, with TKPI (fishing vessel engineering) treated as Health & Maritime. Cross-cutting vocational subjects taught in every program, namely Creativity, Innovation, and Entrepreneurship (KIK/PKK) and Public Speaking, were placed in Business & Management because of their entrepreneurial content, Informatics in Engineering & Technology, and the Art teacher at SMKN 1 Panji, whose electives belong to the design and creative programs, in Tourism & Creative Crafts. These assignments are the author's judgment. Nine respondents were not assigned to any of the four clusters: five in Health & Maritime, which was too small for separate estimation, and four whose subject could not be tied to a single cluster (Mathematics, Project IPAS, Basic Program Skills, and one teacher serving eight programs). The analysis therefore covers 159 of the 168 respondents (57 + 57 + 26 + 19).

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Table 8. Path Coefficients by Expertise Cluster (n ≥ 19)

Path	Engineering & Technology (n=57)	Business & Management (n=57)	Tourism & Creative Crafts (n=26)	Agribusiness (n=19)
Competence → SRL	0.399	0.606	0.113	0.467
Digital Literacy → SRL	0.200	0.167	0.398	0.166
Competence → Teacher Performance	0.386	0.275	-0.042	-0.110
Digital Literacy → Teacher Performance	0.194	0.007	0.327	0.331
SRL → Teacher Performance	0.458	0.311	0.086	0.685

Table 9. Results of Between-Group Path Difference Testing by Expertise Cluster (p < 0.10)

Groups Compared	Path	Δβ	p-value
Engineering & Technology vs Agribusiness	Competence → Teacher Performance	0.496	0.054
Business & Management vs Tourism & Creative Crafts	Competence → SRL	0.493	0.004

Across expertise clusters, only two of the 30 path-and-cluster-pair comparisons showed significant or marginal differences at $p < 0.10$ (Tables 8 and 9), and after Benjamini–Hochberg adjustment only one remained near that threshold ($q \approx 0.08$). The path from industry-based professional competence to self-regulated learning was higher in the Business & Management cluster ($\beta = 0.606$) than in the Tourism & Creative Crafts cluster ($\beta = 0.113$), and the path from competence to teacher performance was higher in the Engineering & Technology cluster ($\beta = 0.386$) than in the Agribusiness cluster ($\beta = -0.110$). Given the small clusters (n = 19 to 57), the liberal threshold, and the number of comparisons, these differences are exploratory and should be interpreted tentatively; the absence of other significant differences is not evidence that the paths are equivalent across clusters. Possible explanations, such as the characteristics of project-based learning in the Agribusiness cluster or the more structured nature of industrial collaboration in the Business & Management cluster, remain speculative and call for verification in larger samples. Leaving out the 14 respondents whose teaching load is mainly general subjects (145 respondents in the clusters) flagged the same two comparisons plus one additional borderline comparison, and none remained below 0.10 after adjustment.

The importance-performance map analysis for teacher performance is presented in Table 10.

Table 10. Importance-Performance Map Analysis (Target: Teacher Performance)

Construct	Importance (Total Effect)	Performance (0–100)
Industry-Based Professional Competence (X1)	0.405	76.9
Digital Literacy (X2)	0.217	68.7
Self-Regulated Learning (M)	0.414	77.0

Table 10 places digital literacy in the position most in need of attention: this construct has both the lowest importance and lowest performance among the three predictors of teacher performance, indicating that improvement in this construct is associated with performance in the model while also targeting the area with the lowest current achievement. In contrast, self-regulated learning and industry-based professional competence are already at high performance levels (77.0 and 76.9) with correspondingly high importance, so that strategies for both are more appropriately directed toward maintaining achievement than pursuing fundamental improvement. At the indicator level, the item on independently resolving technical problems (X2.3.1) was recorded as the indicator with the lowest performance among all digital literacy items (62.2 on a 0–100 scale), making it the most concrete intervention target for teacher digital literacy strengthening programs.

Discussion

The pattern of results supports all seven hypotheses (H1–H7), but the most notable feature of the model lies not in the significance of each path but in the distribution of their strength. Competence and digital literacy were both positively associated with teacher performance (H1, H2) and with SRL (H3, H4), and SRL was positively associated with performance (H5), with an effect size several times larger than the direct paths from either exogenous variable. About 47% of the combined direct and indirect association between industry-based professional competence and teaching performance, and about 38% of that for digital literacy, runs through SRL (H6, H7; partial mediation). Read through social cognitive theory, which holds that standard-setting, monitoring, and self-evaluation shape whether possessed knowledge is carried into action (Bandura, 1991; Woreta et al., 2025), and through the three-phase self-regulation model that positions reflection as the link between experience and subsequent improvement (Zimmerman, 2002), this pattern is consistent with the interpretation that technical mastery and digital proficiency function as resources whose relationship with performance is partly carried by teachers' self-regulation, a pattern also observed in professional contexts outside education (Elmadag et al., 2023). Because the data are cross-sectional and self-reported, however, this is a statistical mediation pattern that is consistent with such a process but does not demonstrate it; the reverse ordering, in which teachers who perform well also regulate their learning more actively, cannot be ruled out.

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For the design of teacher professional development, the results suggest that added competence is associated with performance largely in combination with teachers' ability to manage their own learning, given that the direct paths were small ($f^2 = 0.058$ and 0.028). Training, internships, and certification have so far been evaluated mainly through outcomes in the form of added competence, so these results extend research positioning motivation and professional development as mediators of vocational teacher performance (Kholifah et al., 2024) by pointing to a possible metacognitive pathway alongside motivational ones, although motivation was not measured here. They are also in line with the technology-assisted self-regulation competence framework developed for vocational teachers (Shyr et al., 2025) and with evidence that self-regulation capacity can be fostered through planned intervention instead of being merely an individual trait (Mejeh & Held, 2022), although the present data cannot show that strengthening SRL would raise performance.

Industry-based professional competence emerged as the strongest correlate of self-regulation (H3). This may reflect the structured nature of industrial experience: facilitated internships and involvement in Teaching Factory place teachers in situations with external quality standards, measurable targets, and direct feedback, which may reinforce the cycle of goal-setting, monitoring, and self-evaluation, although these conditions were not measured directly. The pattern aligns with findings that school-industry partnerships support the sustainable development of vocational teachers (Huo & Zhang, 2025; Zhang et al., 2022) and that industrial internships contribute to teaching readiness (Akhyar et al., 2024; Herawati et al., 2021). Within the professional capital framework, such experience can be read as enriching decisional capital, namely teachers' capacity to independently weigh and decide on professional action, going beyond the addition of human capital in the form of subject mastery (Rodriguez-Gomez et al., 2024; Hargreaves & Fullan, 2012; Ranu et al., 2024). Because the certification item was removed from the competence construct, this interpretation applies to practical competence and industrial engagement rather than to formally credentialed competence.

Digital literacy shows a different pattern. It obtained the lowest descriptive score and produced the weakest paths, both to self-regulation (H4) and to performance (H2). Its weakest item, the ability to independently resolve technical problems, is in fact the item most closely aligned with the notion of self-regulation, so the weakness of these paths may be a consequence of digital mastery that remains at the operational level. These findings echo reports of an imbalance in educators' digital competence in the pedagogical and problem-solving dimensions (Arimbawa et al., 2024; Ningsih & Akhyar, 2024) and qualify studies reporting a relationship between digital literacy and performance without differentiating the level of mastery (Dharma, 2022; Xin et al., 2024). A recent meta-analysis reports a moderate positive correlation between digital literacy and SRL that varies with how the constructs are defined and measured and with participant and geographic characteristics (Lan et al., 2025); the weaker paths here may therefore reflect measurement and context more than irrelevance of digital literacy, and the cross-sectional design cannot establish the direction of the relationship. The digital competence framework for educators that positions problem-solving as the highest dimension supports this interpretation (Redecker & Punie, 2017).

The very high and evenly distributed teacher performance scores across all four dimensions need to be interpreted with caution, because performance, like every other construct, was measured by self-assessment in the same survey. Self-assessment tendencies and common

method variance may inflate both the scores and the associations among constructs, and the VIF diagnostic cannot rule this out; the findings therefore concern teachers' reported perceptions, not independently observed performance. With that caveat, the stable distribution of scores across respondent subgroups, with small and directionally inconsistent differences between groups, suggests that the high ratings were not determined solely by direct industrial exposure, and the exploratory multigroup results (Tables 6 to 9), which rest on small subgroups, add only tentative nuance to this picture. The only relatively lagging dimension was learning time management, which intersects with the weakest self-regulation item, namely setting competence targets and allocating self-development time. This overlap suggests that the teacher performance issue in this research setting may lie less in subject mastery than in the management of time and attention resources, an aspect that teaching effectiveness research links to structural clarity and cognitive strategy in learning (Hattie, 2023; Mastrokoukou et al., 2022; Yeo, 2024). Studies on educator readiness also show that adaptation and support for student diversity are often rated highly in subjective terms but are not necessarily reflected in documented practice (Arias-Pastor et al., 2023), so data sources other than self-assessment deserve consideration in future research. On a broader level, the use of digital learning traces to monitor the development of teachers' professional capital offers a promising methodological direction (de La Hoz-Ruiz et al., 2024), as does the systematic effort to strengthen professional competence through scheduled upskilling programs (Siagian, 2023) and the conceptual testing of the relationship between competence and performance (Aindra et al., 2022; Arma, 2024).

Conclusion

This study found that industry-based professional competence and digital literacy were positively and significantly associated with teacher performance, both directly and indirectly through self-regulated learning, which partially mediated both relationships in the statistical model. Taken together, the research problem, objectives, and results are consistent with the view that self-regulation capacity is an important pathway linking teachers' professional capital to teaching performance, rather than a merely complementary variable. Given the cross-sectional, self-reported design, this reflects modeled associations among reported perceptions and not demonstrated causal transmission.

The strengths of this study lie in its census coverage of the entire population with a full response rate, in the simultaneous testing of two sources of professional capital within one integrated model, and in the use of competence indicators reflecting structured experience instead of formal qualifications alone. Its limitations lie in the cross-sectional design, which does not allow temporal or causal conclusions; in the use of self-assessment from the same survey for all constructs, including performance, which carries a risk of self-assessment and common method bias that the VIF diagnostic cannot exclude; in the absence of a separate pilot test of the instrument; in the very high reliability of the teacher performance scale, which may partly reflect overlapping items and uniform self-ratings; in the inclusion criterion, under which 14 respondents teach mainly general subjects alongside a vocational subject; in the removal of the certification item, which narrows the coverage of the competence construct; in the exploratory nature of the multigroup analyses, which rest on small subgroups, a liberal significance threshold, and many comparisons; and in the model's explanatory power, which still leaves considerable room for variables outside the model, as reflected in coefficients of determination classified as weak to

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moderate. The descriptive scores consistently falling in the high to very high category also indicate a possible ceiling effect, common in self-report Likert-scale instruments, which may partly explain why the model's explanatory power is moderate despite all paths being statistically significant. The study's scope, limited to productive-subject teachers at state schools in a single regency, also constrains the generalizability of the findings.

In practical terms, the findings suggest that teacher professional development programs may benefit from being designed as an integrated whole that does not stop at competence transfer. Protected self-development time outside teaching hours, mentoring in setting individual competence targets, and ongoing tiered technical mentoring are options worth piloting and evaluating rather than established remedies, since these data cannot show that such measures would raise performance. Strengthening digital literacy may be directed toward independent problem-solving and not only mastery of applications, particularly as the item on independently resolving technical problems had the lowest performance in the importance-performance map analysis. The exploratory multigroup analyses hint that the strength of the path from self-regulated learning to teacher performance varies by tenure and that a few paths differ across expertise clusters, but these differences are tentative and should be verified in larger samples before informing differentiated programs. Future research is recommended to add explanatory variables such as managerial support, organizational climate, work motivation, and self-efficacy, to use longitudinal or experimental designs to strengthen causal conclusions, to complement self-assessment with classroom observation or supervisor appraisal, and to extend the research setting to private schools and to regions with different industrial ecosystems and digital infrastructure.

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