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# Digital Literacy, Self-Regulated Learning, and Pedagogical Competence as Determinants of Learning Quality

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**Abstract**

**Purpose:** This study examined the relationships between teacher digital literacy, self-regulated learning (SRL), and pedagogical competence with learning quality in public junior high schools in Jekulo District, Kudus Regency, Indonesia, where evidence from non-urban contexts remains limited.

**Method:** A quantitative survey was conducted with 112 teachers from three public junior high schools selected through proportional random sampling. Data were collected using validated Likert-scale questionnaires and analysed using Partial Least Squares Structural Equation Modelling (SmartPLS 4.0).

**Results:** The measurement model demonstrated satisfactory validity (AVE > 0.50; loadings > 0.70) and reliability (Cronbach's alpha and composite reliability > 0.70). The structural model showed acceptable fit (SRMR = 0.078). Digital literacy positively influenced learning quality ($T = 3.468$, $p = 0.001$, $f^2 = 0.15$), whereas SRL was not significant ($T = 0.956$, $p = 0.339$, $f^2 = 0.012$). Pedagogical competence was the strongest predictor ($T = 7.785$, $p < 0.001$, $f^2 = 0.63$). The model explained 77.6% of the variance in learning quality ($R^2 = 0.776$).

**Novelty and Contributions:** This study is among the first to compare the relative effects of digital literacy, SRL, and pedagogical competence on learning quality in a non-urban Indonesian context. It identifies pedagogical competence as the dominant predictor while showing that SRL alone does not significantly improve learning quality.

**Social and Practical Implications:** The findings support prioritising pedagogical competence alongside digital literacy in teacher professional development. Policymakers and school leaders should design integrated capacity-building programmes to strengthen classroom instruction and improve learning quality in public schools.

**Keywords:** Digital Literacy; Self-Regulated Learning; Pedagogical Competence; Learning Quality

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# 1 Introduction

Learning quality is widely regarded as the primary indicator of educational effectiveness, reflecting the extent to which teacher-student interactions, instructional design, and the learning environment collectively contribute to meaningful, long-term knowledge acquisition (Creemers & Kyriakides, 2007). Globally, concerns about learning quality have grown in recent years, driven by large-scale assessments such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), which consistently reveal significant disparities between high- and low-performing education systems. These disparities are not solely due to resource differences; substantial evidence indicates that teacher quality, particularly pedagogical skill and professional competence, is among the most important school-level determinants of student learning outcomes (Hattie, 2008; Révai & Guerriero, 2017).

Successive PISA cycles in Indonesia have pushed the issue of learning quality to the forefront. Indonesia's PISA 2022 results ranked the country 69th out of 80 participating countries and sixth in ASEAN, indicating ongoing issues in fundamental reading and numeracy. National educational reform agendas, such as the Merdeka Belajar (Freedom to Learn) policy framework and the revised Kurikulum Merdeka, have emphasised the need for teachers to transition from rote instruction to more student-centred, competency-based pedagogical practices (Ministry of Education, Culture, Research, and Technology [Kemendikbudristek], 2022). However, the translation of these policy goals into improved classroom learning quality, particularly in non-urban and semi-rural settings, is unequal and understudied.

The growing integration of information and communication technology (ICT) into educational settings has altered expectations of teacher competency. Digital literacy, defined broadly as the ability to acquire, critically analyse, create, and share information using digital resources, has emerged as a core professional skill for teachers in the twenty-first century (Ilomaki et al., 2016; Redecker, 2017). The European Framework for the Digital Competence of Educators (DigCompEdu) defines digital literacy in six domains: professional engagement, digital resources, teaching and learning, evaluation, empowering learners, and enabling learners' digital competence (Redecker, 2017).

Empirical research consistently reveals that higher levels of teacher digital literacy are associated with more effective teaching methods, increased student engagement, and better learning outcomes (Pettersson, 2021; Tondeur et al., 2017). Teachers with excellent digital literacy are better positioned to select, modify, and deploy digital resources in ways that correspond with pedagogical aims, rather than just layering technology on top of existing practice (Mishra & Koehler, 2006). In Indonesia, however, surveys show that the majority of teachers still have basic levels of digital competence, and access to excellent professional development in digital skills is unevenly distributed across school settings (Anggraini et al., 2024; Fauziah et al., 2023). Research specifically conducted in Kudus Regency has highlighted that the digital competence level of junior high school teachers remains low and is not fully adaptive to contemporary digital demands (Yusro, 2024).

Self-regulated learning (SRL) is a metacognitive, motivational, and behavioural process in which people actively govern their own learning by setting objectives, tracking progress, using adaptive methods, and evaluating outcomes (Zimmerman, 2002; Zimmerman & Schunk, 2011). SRL, when applied to teachers as professional learners, refers to the ability to explore professional knowledge independently, reflect critically on practice, and alter instructional behaviour in response to evidence and feedback (Karlen et al., 2020).

Teachers with high SRL capability are expected to engage in ongoing professional learning, develop creative instructional practices, and be more resilient in the face of educational change (Pintrich, 2004). Karlen et al. (2020) offer a dual-role model of teacher SRL that distinguishes teachers as self-regulated learners and facilitators of SRL in their students. Both positions are deemed vital for maintaining high-quality training. Despite its theoretical significance, empirical evidence on the direct relationship between teacher SRL and objectively evaluated learning quality is less consistent than that on professional development outcomes (Dignath & Buttner, 2008; Daumiller et al., 2021). Some studies suggest that the impact of teacher SRL on student-facing learning quality may be moderated by institutional conditions, school culture, and the availability of structured professional support (Karlen et al., 2020).

Pedagogical competence refers to the knowledge, skills, and attitudes that teachers need to effectively develop, implement, manage, and evaluate learning experiences (Shulman, 1987; Révai & Guerriero, 2017). The Indonesian national framework codifies teacher competence across four domains: pedagogical, professional, social, and personal competence, with pedagogical competence widely regarded as the most directly consequential for instructional quality (Law No. 14/2005 on Teachers and Lecturers; Kemendikbudristek, 2022). Understanding students'

developmental characteristics, designing learning that aligns with curriculum standards, selecting appropriate instructional methods, managing the classroom environment, and administering formative and summative assessments are all examples of pedagogical competence (Shulman, 1987; Darling-Hammond, 2000). A substantial body of research shows that pedagogical competency is one of the most powerful school-level predictors of learning quality and student accomplishment (Hattie, 2008; Révai & Guerriero, 2017; Darling-Hammond et al., 2017). In the Indonesian setting, studies at both primary and secondary school levels consistently show that teacher pedagogical ability and learning quality are positively and significantly related. The processes by which pedagogical competency operates include lesson design quality, classroom management effectiveness, teaching differentiation for diverse learners, and learning assessment accuracy and utility.

Prior research has looked at digital literacy, SRL, and pedagogical ability as factors in learning quality, but mostly in isolation or with little contextual specificity. Studies on digital literacy and learning quality have predominantly been conducted at the college level or in urban school settings (Rachmawati et al., 2022; Pettersson, 2021). Theoretically, teacher SRL and its relationship to classroom results are well-developed, but empirically, effect sizes vary significantly among school contexts and levels (Dignath & Buttner, 2008; Daumiller et al., 2021). Although there are more studies on pedagogical competence at the junior high school level in Indonesia, the majority of them have looked at it in isolation from digital and self-regulatory aspects (Sukardi et al., 2023; Satiri et al., 2025).

Ningrum et al. (2024) did an analogous study in Bambel District (North Sumatra) on a similar set of factors at the junior high school level and discovered substantial effects of all three predictors, including SRL. However, geographical disparities in school characteristics, teacher profiles, and institutional support systems may result in distinct patterns of influence. Correspondingly, Masruroh et al. (2023) investigated comparable variables in Dolopo District (East Java), but used an unpublished thesis approach with limited generalisability. Studies that examine the relative contributions of digital literacy, SRL, and pedagogical competence in a single structural model and report effect sizes enabling comparison of their relative importance are scarce, particularly at the junior high school level in non-urban Central Java.

This study, therefore, addresses a contextually specific gap: the relative contributions of teacher digital literacy, SRL, and pedagogical competence to learning quality in public junior high schools in Jekulo District, Kudus Regency. Jekulo is a semi-rural sub-district with documented challenges in teacher digital competence and uneven implementation of curriculum reform, making it a relevant and underserved context for educational research.

The present study was designed to test the following hypotheses:

$H_1$: Teacher digital literacy is positively and significantly associated with learning quality in public junior high schools in Jekulo District.

$H_2$: Teacher self-regulated learning is positively and significantly associated with learning quality in public junior high schools in Jekulo District.

$H_3$: Teacher pedagogical competence is positively and significantly associated with learning quality in public junior high schools in Jekulo District

## 2 Method

### 2.1 Research Design

This study employed a quantitative, cross-sectional survey design. The use of a survey instrument enabled systematic measurement of teacher perceptions of digital literacy, self-regulated learning, and pedagogical competence, as well as their assessment of learning quality, across multiple school settings within a single administrative district.

### 2.2 Population and Sample

The study population comprised all teachers, both civil servants (PNS) and non-civil servants, employed at three public junior high schools (SMP Negeri 1, 2, and 3) in Jekulo District, Kudus Regency, totalling 112 teachers. Given the manageable population size, the researcher applied the Slovin formula to determine the minimum sample size. Proportional random sampling was used to ensure that each school was represented in the sample according to its

proportion of the total teacher population. The final sample included all 112 teachers, consistent with a census approach for small populations.

### 2.3 Instruments

Data were collected using a self-administered questionnaire with five-point Likert-scale response options (1 = strongly disagree to 5 = strongly agree), distributed online via Google Forms. The questionnaire comprised four sections corresponding to the four constructs: digital literacy (Section A), self-regulated learning (Section B), pedagogical competence (Section C), and learning quality (Section D). Items were developed based on established theoretical frameworks and adapted to the Indonesian junior high school context.

### 2.4 Data Analysis

Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) with SmartPLS 4.0. PLS-SEM was selected because it is appropriate for predictive modelling with smaller samples, and because the study's primary aim was to assess the relative contributions of predictor variables rather than to confirm a strictly confirmatory theoretical model (Hair et al., 2019). The analysis proceeded in two stages: (1) outer model (measurement model) assessment, including convergent validity (loading factors and AVE), discriminant validity (cross-loadings), and reliability (Cronbach's alpha and composite reliability); and (2) inner model (structural model) assessment, including model fit (SRMR), significance testing via bootstrapping (5,000 iterations), R-squared, and effect size (Cohen's $f^2$).

## 3 Results

### 3.1 Model Testing (Outer Model)

The Outer Model is a value that explains the relationship (correlation) between an indicator and its latent variable, focusing on the relationship between the latent variable and the indicator (Sarstedt et al., 2021). Testing the Outer Model aims to ensure that the instrument used to measure the latent variable has good validity and reliability. The outer model was assessed using three criteria: convergent validity, discriminant validity, and composite reliability.

### 3.2 Convergent Validity

Convergent validity is the extent to which a construct converges in its indicators by explaining item variance (Sarstedt et al., 2021). Convergent Validity has two evaluation criteria: the Loading Factor value and the Average Variance Extracted (AVE) value.

#### 3.2.1 Loading Factor Value

Indicators on the loading factor are considered valid if they have a correlation value above 0.7 (Hair et al., 2019). The output of the loading factor value of the third stage of testing all statements of the variables of digital literacy, self-regulated learning, teacher pedagogical competence and learning quality have a value > Loading Factor, namely 0.7 so that all are said to be valid, indicating that the statement indicators used successfully measure the correlation between the statement indicator scores and the construct, thus supporting the construct validity of the measurement model.

**Table 1** Outer Loading Results of Convergent Validity Test Stage 3

| No | Digital Literacy | Self-Regulated Learning | Pedagogical Competence Gr | Quality of Learning | Information |
|---|---|---|---|---|---|
| A3 | 0.806 | | | | Valid |
| A4 | 0.793 | | | | Valid |
| A5 | 0.706 | | | | Valid |
| A6 | 0.835 | | | | Valid |
| A7 | 0.837 | | | | Valid |
| A9 | 0.777 | | | | Valid |
| A10 | 0.713 | | | | Valid |
| A11 | 0.728 | | | | Valid |
| A12 | 0.766 | | | | Valid |
| A13 | 0.812 | | | | Valid |
| A15 | 0.849 | | | | Valid |
| B2 | | 0.795 | | | Valid |
| B6 | | 0.840 | | | Valid |
| B7 | | 0.763 | | | Valid |
| B10 | | 0.885 | | | Valid |
| B11 | | 0.723 | | | Valid |
| B13 | | 0.902 | | | Valid |
| B15 | | 0.937 | | | Valid |
| C1 | | | 0.719 | | Valid |
| C10 | | | 0.792 | | Valid |
| C11 | | | 0.760 | | Valid |
| C12 | | | 0.739 | | Valid |
| C13 | | | 0.742 | | Valid |
| C14 | | | 0.763 | | Valid |
| C15 | | | 0.783 | | Valid |
| C16 | | | 0.719 | | Valid |
| C17 | | | 0.803 | | Valid |
| C19 | | | 0.852 | | Valid |
| D1 | | | | 0.737 | Valid |
| D2 | | | | 0.738 | Valid |
| D3 | | | | 0.752 | Valid |
| D4 | | | | 0.752 | Valid |
| D5 | | | | 0.769 | Valid |
| D10 | | | | 0.735 | Valid |

### 3.2.2 Average Variance Extracted (AVE)

A variable is considered valid if it has an Average Variance Extracted (AVE) value of >0.5. The AVE values for each variable are: digital literacy, 0.688; self-regulated learning, 0.749; teacher pedagogical competence, 0.590; and learning quality, 0.580. These three variables have values > 0.50, meaning that all four variables are categorised as valid.

**Table 2** AVE Results of Convergence Validity Test

| | Average Variance Extracted (AVE) | Information |
|---|---|---|
| Digital Literacy | 0.688 | Valid |
| Self-Regulated Learning | 0.749 | Valid |
| Teacher Pedagogical Competence | 0.590 | Valid |
| Quality of learning | 0.580 | Valid |

### 3.3 Discriminant Validity

The discriminant validity of a model is considered good when each indicator of a latent variable has the highest loading relative to the loadings of other latent variables (Mahardini et al., 2023). The discriminant validity test yielded a loading factor for the indicator of the latent variable that was greater than the loading factor values of the other latent variables. This indicates that each variable has good discriminant validity.

**Table 3** Cross-Loading Results of Discriminant Validity Test

| | Digital Literacy | Self-Regulated Learning | Pedagogical Competence Gr | Quality of Learning | Information |
|---|---|---|---|---|---|
| **A4** | **0.861** | 0.633 | 0.636 | 0.685 | Valid |
| **A7** | **0.843** | 0.809 | 0.485 | 0.570 | Valid |
| **A9** | **0.836** | 0.600 | 0.632 | 0.684 | Valid |
| **A12** | **0.798** | 0.647 | 0.561 | 0.715 | Valid |
| **A13** | **0.808** | 0.780 | 0.492 | 0.559 | Valid |
| **B2** | 0,629 | **0,805** | 0,582 | 0,651 | Valid |
| **B6** | 0,800 | **0,848** | 0,551 | 0,633 | Valid |
| **B7** | 0,580 | **0,782** | 0,567 | 0,630 | Valid |
| **B10** | 0,734 | **0,895** | 0,539 | 0,591 | Valid |
| **B13** | 0,745 | **0,904** | 0,559 | 0,595 | Valid |
| **B15** | 0,797 | **0,946** | 0,608 | 0,666 | Valid |
| **C1** | 0,499 | 0,448 | **0,721** | 0,649 | Valid |
| **C10** | 0,519 | 0,448 | **0,789** | 0,629 | Valid |
| **C11** | 0,532 | 0,592 | **0,763** | 0,655 | Valid |
| **C12** | 0,551 | 0,475 | **0,739** | 0,639 | Valid |
| **C13** | 0,518 | 0,479 | **0,741** | 0,614 | Valid |
| **C14** | 0,437 | 0,467 | **0,764** | 0,589 | Valid |
| **C15** | 0,558 | 0,546 | **0,780** | 0,654 | Valid |
| **C16** | 0,463 | 0,474 | **0,718** | 0,520 | Valid |
| **C17** | 0,553 | 0,500 | **0,804** | 0,652 | Valid |

| | Digital Literacy | Self-Regulated Learning | Pedagogical Competence Gr | Quality of Learning | Information |
|---|---|---|---|---|---|
| **C19** | 0,598 | 0,612 | 0,853 | 0,718 | Valid |
| **D2** | 0,589 | 0,510 | 0,694 | **0,749** | Valid |
| **D5** | 0,666 | 0,656 | 0,602 | **0,775** | Valid |
| **D10** | 0,637 | 0,508 | 0,610 | **0,731** | Valid |
| **D12** | 0,473 | 0,483 | 0,613 | **0,779** | Valid |
| **D13** | 0,639 | 0,537 | 0,693 | **0,809** | Valid |
| **D15** | 0,593 | 0,559 | 0,693 | **0,809** | Valid |
| **D16** | 0,603 | 0,537 | 0,675 | **0,796** | Valid |
| **D18** | 0,530 | 0,563 | 0,593 | **0,739** | Valid |
| **D19** | 0,614 | 0,601 | 0,539 | **0,727** | Valid |
| **D20** | 0.608 | 0,656 | 0,602 | **0,775** | Valid |

### 3.4 Construct Reliability (Composite Reliability and Cronbach's Alpha)

If all latent variable values have a Composite Reliability or Cronbach's Alpha value > 0.70, it means that the construct has good reliability, and the questionnaire used as a tool in this study is consistent (Ramadhan & Santoso, 2026).

**Table 4** Values of Cronbach's Alpha and Composite Reliability

| | Cronbach's alpha | Composite Reliability | Information |
|---|---|---|---|
| Digital Literacy | 0.887 | 0.891 | Reliable |
| Self-Regulated Learning | 0.932 | 0.933 | Reliable |
| Pedagogical Competence Gr | 0.922 | 0.925 | Reliable |
| Quality of Learning Gr | 0.919 | 0.921 | Reliable |

Based on Table 4, the results of the Cronbach's Alpha and Composite Reliability tests indicate that all latent variables are reliable because all latent variable values have Composite Reliability and Cronbach's Alpha values >0.70. Thus, it can be concluded that the questionnaire used in this study is reliable and consistent.

### 3.5 Model Fit Test

Model fit is used to assess the suitability of the model and data for testing the influence of variables. The SRMR must be less than 0.10 (Memon et al., 2021). Model fit testing is performed by comparing the estimated output of SmartPLS version 4.0 with the criteria described in the following table.

**Table 5** Model Fit Test Results

| | Rule of Thumb | Estimated model | Information |
|---|---|---|---|
| SRMR | < 0.10 | 0.078 | Fit |
| d_ULS | > 0.05 | 3,031 | Fit |
| d_G | > 0.05 | 3,801 | Fit |
| Chi-square | $X^2$ statistic ≥ $X^2$ table | 1212,451 | Not Fit |
| NFI | Approaching the value 1 | 0.606 | Fit |

Based on the model feasibility test conducted in this study, the results indicated that this modification can be used to analyse several inter-latent variables, suggesting that the model accurately fits the data and possesses relevant productive capabilities.

**Inner Model Testing**

The inner model testing stage examines the significance of the influence of exogenous variables on endogenous variables (Memon et al., 2021). This evaluation covers three aspects: the significance of the relationship (hypothesis testing), R-squared, and effect size. The following is the output of the research inner model:

### 3.6 Significance (Hypothesis Testing)

**Table 6** Significance Test Results

| Variables | T statistics (\|O/STDEV\|) | P values | Information |
|---|---|---|---|
| Digital Literacy -> Learning Quality | 3,468 | 0.001 | Proven |
| Self-Regulated Learning -> Learning Quality | 0.956 | 0.339 | Not Proven |
| Pedagogical Competence Gr-> Learning Quality | 7,785 | 0.000 | Proven |

The test results show that digital literacy has a T-statistic value of 3.468 and a P-value of 0.001, whereas teacher pedagogical competence has a T-statistic value of 7.785 and a P-value of 0.000, indicating that both significantly affect learning quality. However, self-regulated learning is not proven to show an effect, indicated by a P-value of 0.339 exceeding the P-value threshold > 0.05.

### 3.7 R-square ($R^2$)

**Table 7** R-square results

| | R-square | R-square adjusted |
|---|---|---|
| Quality of learning | 0.776 | 0.768 |

The results of the analysis reveal that the $R^2$ value is 0.776 and the adjusted $R^2$ is 0.768. This indicates that 77.6% of the variation in learning quality can be explained by digital literacy, self-regulated learning, and teacher pedagogical competence simultaneously, while the remaining 22.4% is explained by other factors outside the model, such as educational background, teaching experience, professional training, work environment, and so on. The adjusted $R^2$ value (0.768) is slightly lower than the $R^2$ value because it accounts for the number of predictors in the model, thereby providing a more accurate estimate of the model's explanatory power, especially when multiple predictors are involved. This model ($R^2$ of 0.776) is included in the strong category ($0.50 \leq R^2 > 0.75$).

### 3.8 Effect Size ($f^2$)

**Table 8** Effect Size

| | Digital Literacy | Self-Regulated Learning | Pedagogical Competence Gr | Quality of Learning | Information |
|---|---|---|---|---|---|
| Digital Literacy | | | | 0.15 | Currently |
| Self-Regulated Learning | | | | 0.012 | Small |
| Teacher Pedagogical Competence | | | | 0.63 | Strong |
| Quality of learning | | | | | |

Table 8 shows that, based on the effect size interpretation guidelines from Cohen (2013) and Hair et al. (2019), the effect of digital literacy on learning quality is $f^2 = 0.15$. This value is included in the medium category ($f^2 \geq 0.15$). Hence, digital literacy provides a moderate but significant contribution to improving the quality of learning. Although the effect is moderate in terms of effect size, it is still statistically significant. The effect of self-regulated learning on learning quality has a value of $f^2 = 0.012$. This value is very small, less than the threshold for a large effect size ($f^2 \geq 0.02$), meaning that self-regulated learning does not have a strong and dominant influence on learning quality. Teacher pedagogical competence is the most dominant factor in explaining variations in learning quality, with a very strong effect ($f^2 = 0.63$), while digital literacy also plays a role, although its contribution is moderate ($f^2 = 0.15$), and still supports strengthening learning quality significantly.

# 4 Discussion

## 4.1 Digital Literacy and Learning Quality

The finding that teacher digital literacy was positively and significantly associated with learning quality ($t = 3.468$, $p = 0.001$) supports Hypothesis 1 and is consistent with a broader literature linking teacher digital competence to instructional quality. The medium effect size ($f^2 = 0.15$) indicates that digital literacy makes a meaningful but not dominant contribution within this model. This finding aligns with studies conducted in Indonesian secondary school settings (Satiri et al., 2025; Damanik & Widodo, 2025) and with the broader international evidence base, which consistently positions teacher digital literacy as a facilitating factor for quality instruction rather than a sufficient condition in its own right (Tondeur et al., 2017; Pettersson, 2021).

The mechanism through which digital literacy appears to be associated with learning quality in this context is likely indirect: teachers with stronger digital literacy are better equipped to select and deploy appropriate digital tools, diversify instructional media, and create more engaging and information-rich learning environments (Mishra & Koehler, 2006; Redecker, 2017). However, the moderate rather than strong effect size in this sample suggests that the benefits of digital literacy are contingent upon the pedagogical context in which it is exercised. Consistent with Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework, digital tools are most effective when teachers can integrate them with sound pedagogical design. This interpretation is supported by the finding that pedagogical competence exerted a substantially stronger effect in the same model, suggesting that digital literacy may amplify the impact of pedagogical skill rather than substitute for it.

The finding is practically significant given the documented challenges of teacher digital literacy in Kudus Regency and similar non-urban Central Java districts (Yusro, 2024; Anggraini et al., 2024). While digital literacy alone is not the most powerful lever available, its statistically significant association with learning quality justifies investment in targeted digital competence development for teachers in this context.

## 4.2 Self-Regulated Learning and Learning Quality

Contrary to Hypothesis 2, self-regulated learning was not significantly associated with learning quality in this sample ($T = 0.956$, $p = 0.339$, $f^2 = 0.012$). This finding warrants careful interpretation rather than a conclusion that SRL is theoretically unimportant. Several contextually plausible explanations deserve consideration.

First, the negligible effect size ($f^2 = 0.012$) suggests extremely limited variance in SRL's contribution to learning quality within this specific sample. This may reflect restricted variance in SRL scores among the teachers sampled: if the majority of teachers report moderate SRL behaviours with little differentiation, the construct will have limited predictive utility within the model, regardless of its theoretical importance (Zimmerman & Schunk, 2011). This explanation is consistent with the observation that teachers in established public schools may converge on stable professional routines that do not vary substantially in terms of self-regulatory engagement.

Second, the relationship between teacher SRL and student-facing learning quality may be mediated by intermediate factors not captured in this model. Karlen et al. (2020) emphasise that the effects of teacher SRL are most visible in contexts where structured professional learning communities, coaching, or formal professional development opportunities provide scaffolding for reflective practice. In the absence of such institutional support, which may be limited in Jekulo District schools, SRL skills that exist at the individual level may not translate into observable

improvements in instructional quality. Similarly, Daumiller et al. (2021) found that teacher SRL had stronger associations with professional learning outcomes than with directly observable instructional behaviours.

Third, administrative and workload pressures characteristic of under-resourced school contexts may constrain the manifestation of SRL in pedagogical practice (Karlen et al., 2020). Even teachers with relatively high SRL capacity may find limited opportunities to apply self-regulatory strategies to the improvement of instruction when class sizes are large, curriculum demands are high, and professional support is limited.

It should be noted that a contrasting result was found by Ningrum et al. (2024) in a comparable study in Bambel District, where SRL was significantly associated with learning quality. This divergence suggests that the relationship between teacher SRL and learning quality may be context-dependent, varying with school culture, regional educational characteristics, and the specific SRL operationalisation used. The present findings do not invalidate the theoretical importance of SRL, but they do suggest that SRL development in isolation is unlikely to produce observable improvements in learning quality without accompanying structural and institutional support.

### 4.3 Pedagogical Competence and Learning Quality

The most robust finding of this study is the strong positive association between pedagogical competence and learning quality ($t = 7.785$, $p < 0.001$, $f^2 = 0.63$). The strong effect size places pedagogical competence as by far the most influential predictor in this model, accounting for a substantially greater proportion of explained variance than either digital literacy or self-regulated learning. This finding is consistent with the extensive literature establishing teachers' pedagogical skill as the most proximal and powerful school-level determinant of learning quality (Hattie, 2008; Darling-Hammond et al., 2017).

The dominance of pedagogical competence in this model is theoretically coherent. Pedagogical competence encompasses the full repertoire of instructional design, student understanding, classroom management, assessment, and learning facilitation skills that directly shape the quality of learning interactions in the classroom. Unlike digital literacy (which depends on access to technology and the quality of tool-specific training) or SRL (whose effects may be moderated by institutional context), pedagogical competence is expressed directly in every lesson that a teacher plans and delivers. This direct expression in practice likely explains why it accounts for substantially more variance in learning quality than the other predictors.

The finding also aligns with the TPACK framework (Mishra & Koehler, 2006), which positions pedagogical knowledge as the foundation upon which technological integration is most effectively built. A teacher with strong pedagogical competence is better positioned to leverage digital literacy strategically, selecting and deploying tools in ways that genuinely enhance learning rather than simply adding technological novelty. This complementary relationship between pedagogical competence and digital literacy is consistent with the observation that both variables were significant predictors of learning quality in this study, while their effect sizes differed substantially.

From a policy perspective, this finding reinforces the priority of pedagogical development in teacher training and professional development programmes. Satiri et al. (2025) reached a similar conclusion in a correlational study of Indonesian high school teachers, arguing that pedagogical competence should be prioritised as the primary lever for improving learning quality, with digital literacy supporting rather than replacing this foundation.

### 4.4 The Combined Model and Practical Implications

The overall model demonstrated strong explanatory power ($R^2 = 0.776$), indicating that the combination of pedagogical competence, digital literacy, and self-regulated learning, even with SRL's non-significant contribution, accounts for a large proportion of variance in learning quality. This suggests that a multidimensional approach to teacher professional development, addressing pedagogical foundations alongside digital integration, is likely to be most effective.

However, the differential effect sizes in this study point clearly toward the primacy of pedagogical competence. Efforts to improve learning quality that prioritise ICT training without commensurate investment in pedagogical skill development may yield limited returns. This is consistent with broader evidence from technology-in-education research, which consistently finds that the presence of digital tools does not automatically improve learning quality without the pedagogical knowledge and skill to use them effectively (Tondeur et al., 2017; OECD, 2015).

# 5 Conclusion

This study examined the relationships between teacher digital literacy, self-regulated learning, pedagogical competence, and learning quality in public junior high schools in Jekulo District, Kudus Regency, Indonesia. Using PLS-SEM analysis of survey data from 112 teachers, the study found that pedagogical competence was the strongest predictor of learning quality ($f^2 = 0.63$, $p < 0.001$), followed by digital literacy as a significant predictor with a medium effect ($f^2 = 0.15$, $p = 0.001$). Self-regulated learning was not significantly associated with learning quality in this context ($f^2 = 0.012$, $p = 0.339$). The three variables together explained 77.6% of the variance in learning quality ($R^2 = 0.776$).

These findings extend the understanding of learning quality determinants in Indonesian non-urban junior high school settings by providing effect-size evidence for the relative impact of three theoretically important teacher-level variables. The results highlight pedagogical competence as the most consequential lever for improving learning quality in this context, while affirming the meaningful but secondary contribution of digital literacy. The non-significant relationship between SRL and learning quality points to the potential role of institutional and contextual moderators in determining when teacher SRL translates into improved classroom practice.

### Practical Implications

#### For School Leadership and Principals

School leaders in Jekulo District and comparable non-urban settings should prioritise investment in pedagogical competence development as the primary strategy for improving learning quality. This includes ensuring that academic supervision (supervisi akademik) focuses substantively on instructional design, student-centred learning strategies, and formative assessment practices—rather than primarily on administrative compliance. Principals should actively facilitate structured pedagogical discussions, lesson study groups, and peer observation programmes.

#### For Teacher Professional Development Policy

Teacher training and in-service professional development programmes should integrate digital literacy within a pedagogically grounded framework rather than treating it as a standalone technical skill. The TPACK model provides a useful organising framework for professional development that helps teachers connect digital tools to specific pedagogical goals and student learning needs. Professional development providers should ensure that digital literacy training is contextualised within subject-specific and age-appropriate instructional challenges.

#### For Self-Regulated Learning Development

Given that SRL did not emerge as a significant predictor in this model, efforts to develop teacher SRL should be embedded within institutional structures that create conditions for its expression in practice. Professional Learning Communities (PLCs), structured peer coaching, and action research programmes may provide the social and institutional scaffolding needed to translate SRL skills into observable improvements in instructional quality. District education offices should consider incorporating PLC development into the school improvement framework for Jekulo District.

#### For District Education Policy

The Kudus District Education Office and related authorities should consider a systematic mapping of teacher pedagogical competence levels across junior high schools as a basis for targeted professional development planning. Given documented low digital literacy levels in the district, a phased approach that first consolidates pedagogical foundations before scaling digital integration may yield more sustainable improvements in learning quality.

## Limitation

Every study has its own limitations, and this study is not without one. Firstly, all constructs were measured using self-report questionnaire items. Teachers' assessments of their own digital literacy, SRL, pedagogical competence, and the quality of their teaching are subject to social desirability bias and may not fully capture objective behavioural differences. Future research would benefit from incorporating observation-based measures of classroom teaching quality and externally validated assessments of teacher competencies.

Additionally, the sample was drawn exclusively from three public junior high schools in a single sub-district (Jekulo District, Kudus Regency). This geographic and institutional specificity limits the generalisability of findings to other sub-districts, other types of schools (private, religious, vocational), or other levels of education. The results should be interpreted as contextually bounded and not extrapolated to Indonesian junior high schools in general.

## Future Research Direction

Based on the findings and limitations of this study, the following directions are recommended for future research.

A longitudinal study tracking changes in teacher digital literacy, SRL, and pedagogical competence over time, and their effects on learning quality, would provide stronger evidence for causal mechanisms and the sustained impact of professional development interventions. Future studies should employ multilevel modelling (HLM) to partition variance in learning quality between teacher-level and school-level factors, enabling a more precise estimation of the contribution of teacher variables while controlling for school-level differences in resources, leadership, and institutional culture. Replication studies across multiple sub-districts, regencies, and provinces in Central Java and beyond would enable examination of whether the dominance of pedagogical competence over digital literacy and SRL is consistent across different regional educational contexts, or whether effect sizes vary with institutional and cultural conditions.

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## Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on request.

## Conflict of Interest

The authors declare no conflicts of interest should be included if there is no conflict of interest.

## Declaration of Use of Generative AI

AI tools were used only for grammar and formatting. No part of the study’s methods, analysis, or results was generated by AI. The authors take full responsibility for the work.

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