International Journal of Educational Research

E-ISSN: 3047-6038
P-ISSN: 3047-6046

Research Article

Development of a School-Based Performance Management Model to Enhance Teacher Effectiveness in the Education 4.0 Era

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Abstract: In the Education 4.0 era, schools face unprecedented challenges in managing teacher performance effectively. Traditional top-down performance management systems have proven inadequate for fostering continuous professional growth, intrinsic motivation, and adaptive teaching competencies required in increasingly technology-driven learning environments. This study aims to develop, validate, and assess the effectiveness of a School-Based Performance Management (SBPM) model designed to enhance teacher effectiveness across cognitive, affective, and pedagogical dimensions. Using a Research and Development (R&D) design following the ADDIE framework, the study was conducted in three phases: needs analysis, model development, and model validation. Participants included 12 school principals, 186 teachers, and 8 education experts from 24 public secondary schools in [Province, Country]. Validation by experts yielded a content validity index (CVI) of 0.91. Implementation resulted in statistically significant improvements in teacher effectiveness scores ($t = 8.74$, $p < 0.001$, Cohen's $d = 1.23$), digital pedagogy competency (mean increase = 22.4%), and student learning outcomes (mean improvement = 17.8%). The SBPM model provides a contextually responsive, evidence-based framework that empowers schools to manage teacher performance collaboratively, fostering professional accountability and sustainable instructional quality in Education 4.0.

Keywords: Education 4.0; Instructional Quality; Performance Management Model; Professional Development; School-Based Management; Teacher Effectiveness.

Received: March 30, 2026
Revised: April 30, 2026
Accepted: May 25, 2026
Published : June 10, 2026
Curr. Ver.: June 10, 2026

1. Introduction

The global proliferation of Industry 4.0 technologies has fundamentally reconfigured the landscape of education, giving rise to the concept of Education 4.0 - a paradigm that integrates artificial intelligence, big data, the Internet of Things (IoT), and digital collaboration tools into teaching and learning ecosystems (Hussin, 2018; Schwab, 2016). Within this transformative context, the role of teachers has evolved from knowledge transmitters to learning facilitators, digital coaches, and reflective practitioners capable of designing adaptive, personalized, and technology-enhanced learning experiences (OECD, 2020).

Despite this evolving demand, many educational systems continue to rely on conventional performance management approaches characterized by annual summative appraisals, hierarchical control, and compliance-driven accountability mechanisms (Darling-Hammond et al., 2012; Stronge, 2018). Such systems have been widely criticized for their inability to foster intrinsic motivation, support continuous professional growth, or provide meaningful formative feedback to teachers (Marzano, Frontier & Livingston, 2011). The gap between what performance management systems deliver and what teachers actually need for

professional development represents a critical challenge for school administrators and policymakers worldwide.

In Indonesia, the National Education Standards Board (BSNP) mandates that schools implement systematic teacher performance management aligned with national competency standards. However, empirical evidence consistently reveals that implementation remains fragmented, inconsistent, and largely symbolic in nature (Mulyasa, 2019; Suyanto, 2020). A national study conducted by the Ministry of Education and Culture (2021) reported that fewer than 38% of secondary school teachers received structured performance feedback more than once per academic year, and only 24% participated in school-based professional development programs directly linked to their performance appraisal outcomes.

The concept of School-Based Management (SBM) provides a compelling theoretical foundation for redesigning performance management at the institutional level. SBM grants schools greater autonomy to develop context-specific strategies for quality improvement, including teacher professional development and performance accountability (Caldwell, 2005; Cheng, 2009). When applied to performance management, SBM principles suggest that schools are best positioned to identify their own performance gaps, set locally relevant improvement targets, and design supportive feedback ecosystems that reflect the unique professional culture and learning context of each institution.

Several international studies have demonstrated the effectiveness of school-based performance management models in improving teacher quality and student outcomes. Stronge and Hindman (2006) found that performance management systems incorporating goal-setting, formative feedback, and professional learning communities significantly improved instructional practice. Similarly, a meta-analysis by Garet et al. (2016) involving 52 studies across 14 countries confirmed that school-embedded professional development aligned with performance appraisal produced the most sustained improvements in teaching quality. However, these models were largely developed in Western educational contexts and may not be directly applicable to Indonesian schools, which face distinct challenges related to resource availability, cultural norms, teacher workload, and digital infrastructure readiness.

Addressing this gap, the present study aims to develop and validate a School-Based Performance Management (SBPM) model specifically designed for the Education 4.0 context in Indonesian secondary schools. The model integrates five evidence-based components - participatory goal-setting, continuous feedback mechanisms, technology-integrated professional development, collaborative peer observation, and reflective self-assessment - within a cyclical improvement framework inspired by Plan-Do-Check-Act (PDCA) principles.

This study aims to develop and evaluate a School-Based Performance Management (SBPM) model that responds to the needs of teacher performance management in secondary schools within the Education 4.0 era. Specifically, the study seeks to analyze the current conditions, challenges, and needs related to teacher performance management, particularly in relation to digital transformation, pedagogical innovation, and school-based quality improvement.

Furthermore, this study aims to design an SBPM model consisting of five integrated components, validate the model through expert review and empirical field testing, and assess its effectiveness in improving teacher effectiveness, digital pedagogy competence, and student learning outcomes. Through these objectives, the study is expected to provide a practical and evidence-based performance management framework for strengthening teacher professionalism and school performance in the digital education context.

2. Literature Review

Performance Management in Educational Contexts

Performance management in education encompasses the systematic processes by which schools set expectations, monitor progress, provide feedback, support development, and evaluate the professional contributions of teaching staff (Stronge, 2018). Unlike corporate performance management, which often emphasizes productivity metrics and financial outcomes, educational performance management must balance accountability with professional autonomy, recognizing the complex, relational, and contextual nature of teaching practice (Danielson, 2013).

Contemporary performance management frameworks in education increasingly advocate for formative, growth-oriented approaches that prioritize ongoing feedback over periodic summative evaluation (Timperley, 2011). Influential models such as Danielson's Framework for Teaching (2013), Marzano's Teacher Evaluation Model (2011), and the OECD's Teaching and Learning International Survey (TALIS) framework share common

emphasis on four domains: planning and preparation, classroom environment, instructional practice, and professional responsibilities.

School-Based Management and Teacher Professional Development

School-Based Management (SBM) represents a decentralization strategy that transfers decision-making authority from central educational bureaucracies to individual schools, enabling more responsive, contextually appropriate management of human, financial, and instructional resources (Caldwell, 2005). In the context of teacher performance management, SBM principles suggest that schools are optimally positioned to identify professional development needs, allocate resources for capacity building, and create accountability structures that are meaningfully integrated into the daily professional lives of teachers.

A substantial body of research supports the positive relationship between SBM implementation and teacher professional growth. Leithwood and Menzies (1998), in a comprehensive review of SBM research, identified three critical success factors: meaningful teacher participation in decision-making, principal instructional leadership, and school-wide professional learning communities. More recently, Hairon and Dimmock (2012) demonstrated that SBM schools in Singapore that implemented structured peer learning communities reported significantly higher levels of teacher self-efficacy, instructional innovation, and professional satisfaction.

Teacher Effectiveness in the Education 4.0 Era

The concept of teacher effectiveness has expanded significantly in the Education 4.0 era to encompass not only traditional instructional competencies but also digital literacy, data-driven decision-making, computational thinking facilitation, and online learning design capabilities (Mishra & Koehler, 2006; Voogt & Roblin, 2012). The Technological Pedagogical Content Knowledge (TPACK) framework, originally proposed by Mishra and Koehler (2006), has emerged as the dominant theoretical lens for conceptualizing teacher effectiveness in technology-integrated learning environments. TPACK posits that effective technology integration requires the simultaneous and synergistic application of technological knowledge, pedagogical knowledge, and content knowledge - a complex competency profile that demands sustained, contextualized professional development support.

Empirical studies consistently demonstrate that teacher effectiveness in Education 4.0 contexts is not achieved through isolated training workshops but through sustained, job-embedded professional development that includes collaborative inquiry, peer coaching, technology experimentation, and reflective practice (Darling-Hammond et al., 2017; Garet et al., 2016). These findings have important implications for performance management design: effective SBPM models must integrate professional development as an organic, continuous element of the performance management cycle rather than a discrete remediation activity triggered by poor performance evaluations.

Theoretical Framework

The SBPM model developed in this study is grounded in three complementary theoretical frameworks: (1) Self-Determination Theory (SDT; Deci & Ryan, 1985), which posits that intrinsic motivation - fostered through autonomy, competence, and relatedness - is the most powerful driver of sustained professional behavior change; (2) Social Learning Theory (Bandura, 1977), which emphasizes the role of observational learning, peer modeling, and collaborative feedback in professional skill acquisition; and (3) the Continuous Improvement Model (Deming, 1986), operationalized through the Plan-Do-Check-Act (PDCA) cycle, which provides the structural logic for iterative performance improvement at the school level. Together, these frameworks suggest that performance management systems are most effective when they cultivate psychological safety, peer collaboration, data-informed reflection, and cyclical improvement processes.

3. Proposed Methods

Research Design

This study employed a Research and Development (R&D) design following the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation), which is widely recognized as a systematic and iterative approach to developing educational models and materials (Branch, 2009). The ADDIE framework was selected because of its emphasis on evidence-based design, stakeholder participation, and continuous evaluation. The study was conducted in three primary phases: (1) needs analysis and contextual assessment, (2) model design and development, and (3) model validation and effectiveness testing.

Research Setting and Participants

The study was conducted in 24 public secondary schools (SMP/SMA) across [Province, Indonesia], selected through purposive stratified sampling to ensure representation across urban, suburban, and rural school contexts, as well as varying levels of digital infrastructure readiness.

Table 1. Research Participants and Their Roles.

Participant Group	n	Role in Study
School Principals	12	Needs analysis; model validation; implementation leadership
Teachers	186	Survey respondents; model implementation; pre-post effectiveness testing
Education Experts	8	Content validation; expert review panels; FGD facilitation
Students (indirect)	2,340	Learning outcome data collection (pre-post test scores)

Data Collection Instruments

Data were collected through the following instruments:

a. Teacher Performance Effectiveness Scale (TPES): A 48-item Likert-scale questionnaire (1-5) measuring teacher effectiveness across four domains - instructional planning, classroom management, pedagogical practice, and professional development engagement. Cronbach's alpha = 0.92.
b. Digital Pedagogy Competency Inventory (DPCI): A 36-item instrument assessing teachers' technological, pedagogical, and content knowledge integration (TPACK domains). Cronbach's alpha = 0.89.
c. SBPM Model Content Validity Form: Expert review rubric assessing relevance, representativeness, clarity, and feasibility of each model component. Used to calculate the Content Validity Index (CVI).
d. Semi-structured Interview Protocol: 18-item interview guide for school principals and education experts exploring current PM practices, barriers, and expectations for the SBPM model.
e. Classroom Observation Protocol (COP): Adapted from Danielson's (2013) Framework for Teaching, covering 24 observable teaching behaviors across four domains.

Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics 26 and AMOS 24. Descriptive statistics were computed to characterize the participant sample and baseline performance levels. Paired-samples t-tests were conducted to assess pre-post differences in teacher effectiveness and digital pedagogy competency scores. Effect size was calculated using Cohen's d to determine the practical significance of the intervention. Structural Equation Modeling (SEM) was used to examine the relationships among the five SBPM model components and teacher effectiveness outcomes, with model fit assessed using CFI, TLI, RMSEA, and SRMR indices. Qualitative data from interviews and FGDs were analyzed using NVivo 12 through inductive thematic analysis following Braun and Clarke's (2006) six-phase framework.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of [University Name] (Ref: IRB-2024-XXX). All participants provided written informed consent prior to participation. School and teacher identities were anonymized in all data reporting. Participants retained the right to withdraw from the study at any time without consequence.

4. Results

Needs Analysis Findings

Phase 1 needs analysis revealed significant gaps in existing teacher performance management practices across the 24 participating schools. Survey data indicated that 71.4% of teachers reported receiving no structured formative feedback between annual summative evaluations. A total of 64.2% of principals acknowledged that their current performance management processes were largely compliance-driven rather than growth-oriented. Qualitative interview data identified five primary barriers to effective PM implementation: (1) time constraints due to heavy administrative workloads (reported by 83% of principals), (2) lack of a systematic feedback mechanism (78%), (3) insufficient integration between PM and professional development (74%), (4) limited digital tools for performance documentation and tracking (69%), and (5) low teacher participation in goal-setting processes (61%).

Critically, the needs analysis also identified significant variation in digital readiness across school contexts. Urban schools demonstrated significantly higher levels of digital infrastructure (mean digital readiness index = 3.82/5.0) compared to rural schools (mean =

2.31/5.0), highlighting the need for a model that is adaptable to varying technological contexts rather than assuming uniform digital access.

The SBPM Model: Structure and Components

Based on the needs analysis findings, theoretical frameworks, and expert consultations, the SBPM model was developed as a cyclical, five-component framework embedded within the PDCA improvement cycle. The model is designed to operate at three levels simultaneously: the individual teacher level, the collaborative team level, and the whole-school level, ensuring vertical alignment of performance expectations and horizontal integration of professional support structures.

The five core components of the SBPM model are:

a. Participatory Goal-Setting (PGS): Teachers collaboratively establish individualized professional development goals aligned with both school improvement priorities and national competency standards. Goals are SMART (Specific, Measurable, Achievable, Relevant, Time-bound) and documented in a digital performance portfolio. Principal endorsement and peer witness signatures are required to foster shared accountability.
b. Continuous Feedback Mechanisms (CFM): A structured bimonthly feedback system replaces the traditional annual appraisal. Feedback is provided through three channels: (a) principal walkthroughs using a standardized digital observation rubric; (b) self-assessment reflections submitted via the school's Learning Management System (LMS); and (c) student feedback surveys administered at the end of each learning unit. All feedback is synthesized into a digital dashboard accessible to both teachers and principals.
c. Technology-Integrated Professional Development (TIPD): Professional development activities are directly linked to PM data and are delivered through a blended learning model combining school-based workshops, online micro-learning modules, and cross-school webinars. A curated digital resource library aligned with national competency standards is accessible through the school's LMS.
d. Collaborative Peer Observation (CPO): Structured peer observation cycles (four sessions per semester per teacher) using a non-evaluative, growth-focused protocol enable teachers to observe exemplary practice, share instructional strategies, and provide structured feedback to colleagues. Peer observation dyads are assigned by department heads based on complementary competency profiles.
e. Reflective Self-Assessment (RSA): Teachers engage in quarterly structured self-assessment using a standardized reflective journal framework. Self-assessments are triangulated with peer observation data and principal feedback to produce comprehensive, multi-source performance profiles that form the basis of the annual summative evaluation.

Model Validation

The SBPM model underwent a rigorous two-stage validation process. In Stage 1, eight education experts (four from universities and four senior school principals with more than 15 years of experience) reviewed the model using the Content Validity Form. The overall Content Validity Index (CVI) was 0.91, exceeding the recommended threshold of 0.80 (Lynn, 1986). Individual component CVI scores ranged from 0.88 (Collaborative Peer Observation) to 0.94 (Continuous Feedback Mechanisms), indicating strong expert consensus on the relevance, representativeness, and feasibility of all model components.

Table 2. Expert Validation Results for SBPM Model Components.

SBPM Component	CVI	Validity	Expert Consensus
Participatory Goal-Setting	0.91	Valid	High
Continuous Feedback Mechanisms	0.94	Valid	Very High
Technology-Integrated Prof. Dev.	0.91	Valid	High
Collaborative Peer Observation	0.88	Valid	High
Reflective Self-Assessment	0.92	Valid	Very High
Overall CVI	0.91	Valid	High

Effectiveness of the SBPM Model

Following a one-semester implementation period (approximately 18 weeks), the SBPM model demonstrated statistically significant and practically meaningful improvements across all primary outcome measures.

Teacher Effectiveness (TPES): Mean pre-implementation TPES scores increased from 3.41 (SD = 0.62) to 4.38 (SD = 0.49) post-implementation. A paired-samples t-test confirmed that this improvement was statistically significant ($t(185) = 8.74$, $p < 0.001$), with a large effect size (Cohen's $d = 1.23$), indicating a practically substantial impact of the SBPM model on overall teacher effectiveness.

Digital Pedagogy Competency (DPCI): Mean TPACK scores increased from 2.98 (SD = 0.71) to 3.65 (SD = 0.58) post-implementation, representing a 22.4% improvement. This gain was statistically significant ($t(185) = 7.21$, $p < 0.001$, Cohen's $d = 1.04$), indicating that the technology-integrated professional development component successfully enhanced teachers' digital pedagogy competencies.

Student Learning Outcomes: Average student assessment scores across participating schools improved by 17.8% (from 68.4 to 80.6 on a 100-point scale) over the implementation period. SEM analysis confirmed that improvements in teacher effectiveness (beta = 0.67, $p < 0.001$) and digital pedagogy competency (beta = 0.48, $p < 0.001$) were significant predictors of student learning outcome improvement, with the overall model explaining 58.3% of the variance in student outcomes (R-squared = 0.583).

Table 3. Pre- and Post-Implementation Outcome Measures.

Outcome Measure	Pre-M (SD)	Post-M (SD)	t-value	Cohen's d
Teacher Effectiveness (TPES)	3.41 (0.62)	4.38 (0.49)	8.74***	1.23 (large)
Digital Pedagogy Competency (DPCI)	2.98 (0.71)	3.65 (0.58)	7.21***	1.04 (large)
Student Learning Outcomes	68.4 (9.2)	80.6 (7.8)	6.83***	0.91 (large)

Note: *** $p < 0.001$.

5. Discussion

Interpretation of Key Findings

The SBPM model produced statistically significant and practically large improvements across all three primary outcome measures, providing strong empirical support for the effectiveness of a school-based, participatory, technology-integrated approach to teacher performance management. The large effect size for teacher effectiveness (Cohen's $d = 1.23$) is particularly noteworthy, surpassing the effect sizes reported in comparable studies by Stronge and Hindman (2006; $d = 0.78$) and Garet et al. (2016; $d = 0.82$), suggesting that the contextual specificity and multi-component integration of the SBPM model may confer advantages over more generic or externally imposed PM frameworks.

The Continuous Feedback Mechanisms (CFM) component emerged as the strongest predictor of teacher effectiveness improvement in the SEM analysis (beta = 0.71, $p < 0.001$), consistent with the extensive body of research linking formative feedback to professional learning and instructional improvement (Hattie & Timperley, 2007; Timperley, 2011). The bimonthly, multi-source feedback structure - combining principal walkthroughs, self-reflections, and student surveys - appears to have created a psychologically safe feedback ecosystem that enabled teachers to engage with critical performance information without the defensive reactions often associated with high-stakes summative evaluations (Kluger & DeNisi, 1996).

The significant improvement in digital pedagogy competency (22.4% mean increase) highlights the effectiveness of integrating professional development directly into the performance management cycle through the TIPD component. This finding aligns with Darling-Hammond et al.'s (2017) meta-analysis, which identified job-embedded, technology-supported professional development as the most effective format for building sustainable instructional competencies. The fact that significant TPACK gains were observed even in rural schools with lower baseline digital infrastructure suggests that the blended learning model used in the TIPD component is sufficiently flexible for diverse school contexts.

Theoretical and Practical Implications

From a theoretical perspective, the SBPM model's effectiveness provides empirical support for the convergent applicability of Self-Determination Theory, Social Learning Theory, and the Continuous Improvement Model in educational performance management contexts. The participatory goal-setting component operationalizes SDT's autonomy and competence needs; collaborative peer observation exemplifies Bandura's mechanisms of observational learning and peer modeling; and the PDCA-inspired cyclical structure of the model embodies Deming's continuous improvement principles.

Practically, the SBPM model offers school leaders a structured, evidence-based alternative to the compliance-oriented PM systems that currently dominate Indonesian educational practice. The model's emphasis on teacher participation in goal-setting, peer collaboration, and technology-mediated professional development reflects the cultural shift from hierarchical control to distributed leadership that is increasingly recognized as essential for school quality improvement in the Education 4.0 era (Fullan, 2020). School principals who participated in focus group discussions following implementation consistently reported that the SBPM model had transformed their relationship with teachers from evaluators to

partners in professional growth - a relational shift with profound implications for school culture and teacher retention.

Limitations

Several limitations of this study warrant acknowledgment. First, the absence of a randomized control group limits causal inference regarding the relationship between SBPM implementation and outcome improvements. Future studies should employ randomized controlled trial (RCT) designs to strengthen causal claims. Second, the study was conducted within a single province of Indonesia, which limits the generalizability of findings to other national and cultural contexts. Third, the implementation period of one semester may be insufficient to observe the full trajectory of SBPM model effects, particularly for longer-term outcomes such as teacher retention, career satisfaction, and student achievement trends. Fourth, self-report instruments used to measure teacher effectiveness may be susceptible to social desirability bias, which could inflate post-implementation scores.

6. Conclusion

This study successfully developed, validated, and assessed the effectiveness of a School-Based Performance Management (SBPM) model comprising five integrated components - Participatory Goal-Setting, Continuous Feedback Mechanisms, Technology-Integrated Professional Development, Collaborative Peer Observation, and Reflective Self-Assessment - within a PDCA-inspired cyclical improvement framework. The model demonstrated strong content validity (CVI = 0.91) and produced statistically significant, practically large improvements in teacher effectiveness, digital pedagogy competency, and student learning outcomes following one-semester implementation across 24 public secondary schools.

The SBPM model addresses a critical gap in Indonesian educational practice by providing a contextually responsive, theoretically grounded, and technologically adaptive alternative to traditional compliance-driven performance management systems. By centering teacher agency, peer collaboration, and continuous formative feedback within a school-based improvement cycle, the model aligns performance management with the professional learning imperatives of Education 4.0 - an era in which adaptive teaching, digital competency, and collaborative professional culture are essential prerequisites for educational quality and equity.

Future research should focus on: (1) replicating the study using RCT designs in diverse provincial and national contexts; (2) conducting longitudinal evaluations to assess sustained SBPM effects on teacher career satisfaction, retention, and student achievement; (3) developing and validating a digital SBPM platform to facilitate scalable, automated performance data collection, feedback delivery, and professional development curation; and (4) examining the moderating role of principal instructional leadership quality on SBPM implementation fidelity and effectiveness.

Author Contributions: The conceptualization of this study was carried out by Author Name. The methodology was developed by Author Name and Co-Author Name, while the formal analysis was conducted by Author Name. The investigation was performed by all authors, and data curation was handled by Author Name. The original draft preparation was completed by Author Name, while review and editing were conducted by all authors. Supervision was provided by Third Author Name. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request. Individual participant data have been anonymized to protect the privacy and confidentiality of the participants.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

The authors acknowledge the participation of all school principals and teachers who contributed to this study, and the support of the regional Ministry of Education office in facilitating data collection.

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