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Empirical Paper

Instructional Leadership, Pedagogical Innovation, and Physical Education Learning Quality

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Abstract

Purpose: This study examined the direct and indirect effects of instructional leadership on learning quality through pedagogical innovation among Physical Education, Sports, and Health (PJOK) teachers in Pati Regency, Central Java, Indonesia.

Methods: A quantitative cross-sectional survey was conducted using covariance-based Structural Equation Modelling (CB-SEM) with IBM AMOS 22. A stratified random sample of 153 teachers was selected from a population of 250. Data were collected using validated five-point Likert-scale instruments. Confirmatory Factor Analysis confirmed satisfactory validity (factor loadings > 0.78; AVE = 0.51-0.57; CR = 0.72-0.75), while Harman's single-factor test indicated no significant common method bias (28.4%).

Results: The model demonstrated excellent fit (χ^2 = 85.532, df = 87, p = .524; RMSEA = .000; CFI = 1.000; GFI = .934; AGFI = .909). Instructional leadership significantly influenced learning quality (β = .212, p = .012) and pedagogical innovation (β = .319, p = .008). Pedagogical innovation positively affected learning quality (β = .318, p < .001) and partially mediated the relationship between instructional leadership and learning quality (indirect effect = .101, 95% CI [.031, .187]). The model explained 31.3% of the variance in learning quality (R^2 = .313).

Novelty and Contribution: The study extends instructional leadership and Diffusion of Innovation theories by establishing pedagogical innovation as the mechanism linking instructional leadership to learning quality in physical education.

Social and Practical Implications: The findings support leadership-focused professional development and teacher innovation initiatives to improve learning quality in emerging education systems.

Keywords: Instructional Leadership; Pedagogical Innovation; Learning Quality; Physical Education; Structural Equation Modelling

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1 Introduction

The global transformation of educational systems in the twenty-first century has fundamentally repositioned the role of the teacher from transmitter of information to architect of meaningful learning experiences. Within this transformed landscape, the quality of classroom instruction has emerged as the single most proximal school-level determinant of student achievement and holistic development (Hattie, 2023; OECD, 2023). Yet instructional quality does not materialise in a vacuum; it is shaped by the organisational context in which teachers work, principally by the leadership of school principals and by the degree to which pedagogical innovation is embedded in daily practice. This nexus of leadership, innovation, and instructional quality constitutes a critical domain of inquiry for educational researchers and policymakers, particularly in emerging economies navigating concurrent pressures of digital transformation, curriculum reform, and the imperatives of Society 5.0.

According to Hallinger (2018), the head teacher plays a central role in directing the academic vision, managing the learning process, and creating a school climate that is conducive to the professional development of teachers. Hallinger (2018) further emphasises that learning leadership is a strategic process that focuses on improving the quality of instruction and student learning outcomes. In line with this, Wahjosumidjo (2011) states that effective school leadership can mobilise the entire school community to work harmoniously and be oriented towards improving learning performance. Thus, the quality of school leadership is crucial to the success of efforts to improve the quality of learning in schools. In addition to school leadership, learning innovation is an important factor that directly contributes to the quality of teacher learning. Learning innovation is understood as planned updates in methods, strategies, media, and learning approaches to improve the effectiveness of the teaching and learning process (Syafaruddin et al., 2020). Kwangmuang et al. (2021) emphasise that learning innovation must be contextual and oriented towards the needs of students to create meaningful learning experiences. In PE learning, innovation is highly relevant because the characteristics of the material demand creativity from teachers in managing physical activities, utilising media, and integrating learning technology.

Physical Education, Sports, and Health (locally designated as Pendidikan Jasmani, Olahraga, dan Kesehatan, or PJOK) occupies a distinctive position within the Indonesian school curriculum. Recognised in Presidential Regulation No. 87 of 2017 on the Strengthening of Character Education, PJOK is understood not merely as a domain for developing students' physical capacities but as a foundational vehicle for cultivating discipline, sportsmanship, resilience, and healthy lifestyle habits aligned with national character-building goals (Ministry of Education and Culture, Republic of Indonesia, 2022). Under the Merdeka Curriculum (Kurikulum Merdeka) and its deep learning framework, PJOK teachers are expected to facilitate learning that is meaningful, contextually responsive, and student-centred, a demand that substantially exceeds the conventions of traditional skills-based physical education pedagogy. Accordingly, the quality of PJOK instruction has become a strategic priority that cannot be addressed through isolated teacher-level interventions alone.

The empirical literature on instructional leadership consistently positions the school principal as the most influential organisational actor in shaping instructional quality. Hallinger's (2005, 2020) foundational instructional leadership model frames the principal's role across three broad functions: defining the school's instructional mission, managing the instructional programme, and promoting a positive school learning climate. Subsequent meta-analytic evidence has quantified this influence: Robinson et al.'s (2008) synthesis of 27 studies reported an average effect size of $d = 0.42$ for instructional leadership on student outcomes, substantially larger than the effect of transformational leadership ($d = 0.11$). However, Hallinger and Heck's (2010) review confirmed indirect effects mediated through school-level conditions, including teacher professional learning and instructional innovation. More recently, Wu et al. (2020) employed multi-level modelling to demonstrate that principals' instructional leadership behaviours predicted the quality of teachers' classroom instruction, with school improvement planning and instructional feedback serving as significant mediators.

Despite this accumulated evidence, critical gaps persist in the literature. First, the majority of instructional leadership research originates from North American, European, and East Asian contexts, leaving the mechanisms of leadership influence in Southeast Asian emerging-economy settings inadequately theorised and empirically tested. Indonesia, with its 530,000 schools, approximately 3.3 million teachers, and an ongoing transition to the Merdeka Curriculum, constitutes a research context of exceptional theoretical and practical significance that has received insufficient scholarly attention in high-impact international journals (Glewwe & Muralidharan, 2022; Sunariati et al., 2023).

Second, the mediating role of pedagogical innovation in the leadership-quality relationship remains underspecified. While studies such as Louis and Wahlstrom (2011) and Daniëls et al. (2019) have conceptualised leadership as an enabling condition for innovation, few studies have operationalised pedagogical innovation as a measured latent construct within an SEM framework, and fewer still have done so within the physical education domain.

These gaps collectively define the empirical and theoretical problem this study addresses. By integrating Hallinger's (2005) Instructional Leadership Model, Rogers' (2003) Diffusion of Innovation Theory, and constructivist learning theory (Vygotsky, 1978), this study develops and tests a theoretically grounded mediation model in which instructional leadership influences learning quality both directly and indirectly through its effect on pedagogical innovation. The study is situated in Pati Regency, Central Java, a mid-sized regency with documented variation in school principal quality and PJOK teacher innovation capacity, providing a meaningful empirical context for theory testing.

The study pursues four research objectives:

i. to examine the direct effect of instructional leadership on the quality of PJOK teacher learning;

ii. to examine the direct effect of pedagogical innovation on the quality of PJOK teacher learning;

iii. to examine the direct effect of instructional leadership on pedagogical innovation; and

iv. to examine the indirect effect of instructional leadership on learning quality mediated by pedagogical innovation.

The findings are expected to yield both theoretical contributions, by extending instructional leadership and innovation diffusion frameworks to physical education in an emerging-economy context, and practical contributions, by informing principal preparation, teacher professional development, and curriculum policy in Indonesia and analogous educational systems.

2 Literature Review and Theoretical Framework

2.1 Instructional Leadership and Learning Quality

Instructional leadership, conceptualised by Hallinger and Murphy (1985) and subsequently refined through two decades of empirical research, refers to the principal's purposeful engagement in the management and improvement of instructional processes and outcomes within the school. Unlike transformational leadership, which operates primarily through vision-setting and motivational inspiration, instructional leadership is characterised by direct involvement in curriculum coordination, classroom observation, teacher feedback, and the alignment of professional development with instructional goals (Hallinger, 2005). This distinction carries empirical weight: Robinson et al.'s (2008) meta-analysis demonstrated that instructional leadership exerted a markedly larger effect on student outcomes ($d = 0.42$) than transformational leadership ($d = 0.11$), attributable precisely to its focus on the technical core of schooling.

Subsequent research has extended the instructional leadership constructs across contexts and educational levels. Sebastian and Allensworth (2012) found that in Chicago public schools, principals' instructional leadership, operationalised through teachers' reports of instructional support and professional development, explained significant variance in reading and mathematics achievement, with effects mediated through improvements in teachers' instructional practices. In a Southeast Asian context, Hallinger et al. (2013) demonstrated, through a 30-year bibliometric analysis, that instructional leadership research has expanded substantially into Asia. Yet, the body of context-sensitive empirical work from Indonesian school settings remains limited. Tan and Dimmock (2014) found that the influence of principals' instructional leadership on teaching quality in Singapore operated through structured professional learning communities, suggesting that the organisational infrastructure created by leaders is as consequential as their direct supervisory behaviours.

In the Indonesian context, Aprilianda et al. (2024) found that school principal leadership significantly predicted teacher performance across primary and secondary schools in South Sulawesi, explaining 38.6% of the variance in teacher performance when combined with organisational climate. Similarly, Riyatno et al. (2024) reported that instructional leadership exerted significant positive effects on learning quality in vocational secondary schools in East Java, with school culture serving as a partial mediator. These findings corroborate the international pattern while underscoring the importance of contextually situated research. However, no study identified in the literature to date

has specifically examined instructional leadership's effects on PJOK learning quality within a mediation framework inclusive of pedagogical innovation.

2.2 Pedagogical Innovation and Learning Quality

Pedagogical innovation refers to the deliberate introduction and implementation of new or substantially improved methods, strategies, technologies, and instructional designs in classroom practice, with the explicit purpose of enhancing the quality and effectiveness of the teaching-learning process (Rogers, 2003; West, 2002). In the context of physical education, pedagogical innovation is particularly salient because the subject's bimodal nature, simultaneously physical and cognitive, demands continuous creativity in managing activity spaces, integrating assessment, utilising digital media, and adapting instruction to diverse physical abilities (Kirk, 2019).

Empirical evidence consistently links pedagogical innovation to positive learning outcomes. Innovative instructional practices, including gamification, technology-enhanced learning, problem-based tasks, and cooperative learning structures, have been associated with increased student engagement, motivation, and achievement across multiple educational domains (Fullan & Langworthy, 2014; Mayer, 2022). In physical education specifically, Farias et al. (2020) demonstrated that teachers who implemented sport education and cooperative learning models reported significantly higher student engagement and skill acquisition compared to traditional direct instruction approaches, emphasising the transformative potential of pedagogical innovation in PE contexts.

Within the Indonesian curriculum reform context, Syafaruddin et al. (2020) identified that PJOK teachers who engaged in innovation through the use of digital learning media, contextual problem-based tasks, and performance-based assessment produced demonstrably superior student learning experiences as measured by both cognitive and affective outcomes. Kwangmuang et al. (2021) further argued that contextual pedagogical innovation, defined as the adaptation of instructional methods to local student characteristics and cultural contexts, is a prerequisite for meaningful learning in Indonesian school settings, particularly under the Merdeka Curriculum framework, which places student agency and contextual relevance at its centre.

2.3 Instructional Leadership as an Enabler of Pedagogical Innovation

The relationship between leadership and innovation has been theorised extensively within organisational and educational literature. Gkorezis (2016) found that empowering leadership behaviours, characterised by autonomy support, participation in decision-making, and confidence expression, significantly predicted teacher innovative behaviour, with psychological empowerment operating as a mediator. Paletta et al. (2017) demonstrated through multi-level analysis across Italian schools that school leadership practices explained 34% of the variance in school-level innovation culture, with vision-setting and professional development support as the strongest predictors.

More specifically, within the physical education literature, Luguetti and Oliver (2021) argued that sustainable pedagogical innovation in PE is structurally dependent on school-level support systems, including principal advocacy, timetabling flexibility, resource allocation, and professional learning time, all of which fall within the principal's instructional leadership repertoire. Without such organisational enablement, individual teacher innovation remains sporadic and unsustained. This theoretical argument aligns with Daniëls et al.'s (2019) systematic review, which found that school leadership was consistently identified as a necessary condition for embedding teaching innovation in schools. Nurjanah et al. (2025) reported in an Indonesian context that academic supervision by school principals directly enhanced teachers' capacity for learning innovation, providing empirical support for the leadership-innovation pathway.

2.4 Theoretical Framework

The conceptual framework of this study integrates three theoretical perspectives. First, Hallinger's (2005) Instructional Leadership Model provides the structural basis for conceptualising how principals influence the instructional context of schools. The model's three dimensions, defining the school mission, managing the instructional programme, and promoting a positive school learning climate, correspond closely to the behaviours that enable pedagogical innovation and, ultimately, learning quality improvement.

Second, Rogers' (2003) Diffusion of Innovation Theory provides the conceptual lens through which pedagogical innovation is understood not as a static characteristic but as a dynamic process of adoption, adaptation, and institutionalisation of new instructional practices. Rogers' framework emphasises that the rate and depth of innovation adoption are shaped by organisational factors, including the support and advocacy of influential figures within the system, a role that maps directly onto the instructional leader. Within this framework, the school principal functions as a change agent who accelerates the diffusion of innovative pedagogical practices by reducing adoption barriers and providing structural support.

Third, Vygotsky's (1978) Social Constructivist Learning Theory informs the conceptualisation of learning quality. If meaningful learning occurs through guided social interaction, collaborative problem-solving, and scaffolded challenge within the zone of proximal development, then learning quality is a function of the richness, intentionality, and adaptiveness of the pedagogical environment created by teachers. Innovative pedagogy, which by definition seeks to enhance the responsiveness and effectiveness of instruction, serves as the proximate mechanism for achieving this quality standard.

Drawing on these three theoretical pillars, the study proposes a conceptual model in which instructional leadership exerts a direct positive effect on learning quality and pedagogical innovation. Pedagogical innovation, in turn, exerts a direct positive effect on learning quality. Consequently, the overall effect of instructional leadership on learning quality comprises both a direct effect and an indirect effect mediated through pedagogical innovation. This model is depicted conceptually with instructional leadership (X1) as the exogenous construct, pedagogical innovation (X2) as the mediating endogenous construct, and learning quality (Y) as the primary endogenous construct.

3 Hypothesis Development

3.1 Instructional Leadership and Learning Quality (H1)

Instructional leadership theory posits that principals who actively define the school's instructional mission, provide structured feedback on teaching, coordinate curriculum alignment, and create conditions for professional learning directly improve the quality of instruction in their schools (Hallinger, 2005; Robinson et al., 2008). Empirical evidence from the Indonesian context further supports this relationship; Aprilianda et al. (2024) found a significant direct effect of principal leadership on teacher learning quality, while Bas (2025) demonstrated that instructional leadership contributes to teacher resource quality through the strengthening of professional development. Based on this theoretical and empirical foundation:

H1: Instructional leadership exerts a significant positive direct effect on the quality of PJOK teacher learning.

3.2 Pedagogical Innovation and Learning Quality (H2)

Pedagogical innovation, operationalised as the adoption and implementation of novel instructional methods, digital media, and contextually responsive assessment practices, has been consistently associated with enhanced learning quality across educational domains (Fullan & Langworthy, 2014; Kirk, 2019). In PE contexts, Farias et al. (2020) demonstrated that innovative instructional models produced superior learning engagement and skill outcomes compared to conventional direct instruction. In Indonesian PJOK settings, Kwangmuang et al. (2021) reported that contextual learning innovation directly improved the quality of students' learning experiences. Accordingly:

H2: Pedagogical innovation exerts a significant positive direct effect on the quality of PJOK teacher learning.

3.3 Instructional Leadership and Pedagogical Innovation (H3)

Teachers' capacity for pedagogical innovation is significantly influenced by the organisational environment created by school leaders (Daniëls et al., 2019; Gkorezis, 2016). Principals who model intellectual curiosity, provide resource support for experimentation, create protected time for professional learning, and explicitly recognise innovative practice signal that innovation is a valued and expected professional behaviour (Paletta et al., 2017). Nurjanah et al. (2025) found that academic supervision by principals in Indonesian schools directly enhanced teachers' innovative instructional capacity. Luguetti and Oliver (2021) similarly identified principal support as a necessary structural condition for sustainable pedagogical innovation in physical education. Therefore:

H3: Instructional leadership exerts a significant positive direct effect on pedagogical innovation among PJOK teachers.

3.4 Pedagogical Innovation as Mediator (H4)

The mediation hypothesis draws on both the instructional leadership literature and Diffusion of Innovation theory to argue that the effect of principal leadership on learning quality is not exclusively direct; rather, it is substantially transmitted through the principal's enabling of teacher innovation. When instructional leaders create an innovation-supportive environment, teachers are more likely to adopt and implement novel pedagogical practices, which in turn improves instructional quality. This theoretical sequence, whereby leadership enables innovation and innovation improves quality, constitutes a conceptually coherent indirect pathway. Louis and Wahlstrom (2011) argued that school-level conditions frequently mediate leadership effects on teaching quality, and teacher innovation capacity is a critical element of these conditions. Empirical support for a mediated pathway is emerging in the Indonesian context, with Riyatno et al. (2024) demonstrating that organisational culture partially mediated the leadership-quality relationship. Based on this theoretical and emerging empirical foundation:

H4: Pedagogical innovation significantly mediates the relationship between instructional leadership and the quality of PJOK teacher learning

4 Methodology

4.1 Research Design

A quantitative, cross-sectional survey design was adopted, analysed using Covariance-Based Structural Equation Modelling (CB-SEM). CB-SEM was selected over Partial Least Squares SEM (PLS-SEM) because the research purpose was theory confirmation, specifically, testing a theoretically derived mediation model, rather than prediction maximisation (Hair et al., 2019). CB-SEM is the appropriate approach when the researcher seeks to evaluate the fit of a pre-specified theoretical model against empirical data and when distributional assumptions can be satisfactorily met (Byrne, 2016). The ex post facto design was employed because the variables of interest, instructional leadership, pedagogical innovation, and learning quality, existed as naturally occurring, non-manipulable organisational phenomena; causal inference is supported by the theoretical model rather than experimental manipulation (Haryono, 2016).

4.2 Population, Sampling, and Ethical Considerations

The target population comprised all Physical Education, Sports, and Health (PJOK) teachers employed in state and private primary and secondary schools (SD and SMP) in Pati Regency, Central Java, Indonesia. According to official enrolment data from the Pati Regency Education and Culture Office (2025), the sampling frame comprised 250 PJOK teachers. Participants were recruited using simple random sampling, ensuring that each population member had an equal and independent probability of selection and thereby minimising sampling bias (Creswell & Creswell, 2018). The required sample size was determined using Slovin's formula with a 5% margin of error, yielding a minimum sample of 153 participants, a figure that also satisfies the rule-of-thumb minimum of ten observations per estimated parameter for CB-SEM with 33 parameters (Hair et al., 2019).

All 153 targeted participants completed and returned valid questionnaires, representing a 100% response rate. This was achieved through direct in-person distribution and collection at scheduled teacher coordination meetings, minimising non-response bias. Ethical safeguards included: written informed consent from all participants; assurances of voluntary participation and withdrawal rights; anonymisation of individual responses; data storage on password-protected institutional servers; and formal research authorisation from the Pati Regency Education and Culture Office. The study was conducted in compliance with institutional ethical guidelines for educational research.

4.3 Instrument Development and Translation

Three Likert-scale instruments were developed to measure the study's constructs. Scale items were initially generated from an extensive review of validated instruments in the instructional leadership, pedagogical innovation,

and learning quality literature. The Instructional Leadership variable (X1) was operationalised using five items adapted from Hallinger's Principal Instructional Management Rating Scale (PIMRS; Hallinger, 2005), focusing on the sub-dimensions of defining the school mission, managing the instructional programme, and promoting a school learning climate. Five items, developed from both Rogers' (2003) innovation adoption framework and the PE-specific pedagogical innovation literature (Kirk, 2019), were used to measure the Pedagogical Innovation variable (X2). 2020), covering dimensions of method innovation, technology integration, and assessment innovation. The Learning Quality variable (Y) was operationalised using five items drawing from the constructivist learning quality framework (Mayer, 2022; Kwangmuang et al., 2021), encompassing dimensions of instructional planning quality, process quality, evaluation quality, and student-centred learning effectiveness. All items were originally developed in Indonesian by the research team and reviewed by two bilingual subject matter experts for conceptual accuracy. A panel of three educational experts confirmed the content validity of the instruments before pilot testing.

A pilot test was conducted with 30 PJOK teachers from a neighbouring regency not included in the main sample. Item-level validity was assessed using Pearson product-moment correlation against the construct total score; items with r-values below 0.30 were revised or eliminated. All 15 final items achieved r-values above 0.50 ($p < .05$), confirming adequate item-level validity. Internal consistency at the pilot stage was acceptable, with Cronbach's alpha values of .74 (instructional leadership), .71 (pedagogical innovation), and .73 (learning quality).

4.4 Validity and Reliability Assessment

In the main study, validity and reliability were assessed through Confirmatory Factor Analysis (CFA) in AMOS 22. The CFA evaluated four psychometric properties essential for CB-SEM: (1) indicator reliability, assessed via standardised factor loadings (threshold: $\lambda \geq .50$; Hair et al., 2019); (2) convergent validity, assessed via Average Variance Extracted (AVE; threshold: AVE ≥ .50; Fornell & Larcker, 1981); (3) construct reliability, assessed via Composite Reliability (CR; threshold: CR ≥ .70; Hair et al., 2019); and (4) discriminant validity, assessed using the Fornell-Larcker criterion, which requires that the square root of each construct's AVE exceeds its inter-construct correlations. All factor loadings in the final CFA model exceeded .78 (range: .783–.874), substantially surpassing the minimum threshold. AVE values ranged from .51 to .57. CR values ranged from .72 to .75. Discriminant validity was confirmed; the square root of AVE for each construct exceeded all corresponding inter-construct correlations.

4.5 Common Method Bias Assessment

Given that all data were collected from a single source (teachers' self-reports) at a single time point, common method bias (CMB) constituted a potential validity threat. Two procedural remedies were implemented: (1) questionnaire items were grouped by construct and separated by brief demographic items to reduce response consistency cues (Podsakoff et al., 2003); and (2) participants were explicitly informed that there were no correct or incorrect answers, reducing evaluation apprehension. Statistically, Harman's (1976) single-factor test was conducted by entering all items into a principal component analysis without rotation. The unrotated first factor explained 28.4% of total variance, substantially below the 50% threshold, providing evidence that CMB does not constitute a serious threat to the validity of the findings.

4.6 Data Analysis Procedures

SEM analysis proceeded through five sequential stages following established best practice (Anderson & Gerbing, 1988; Hair et al., 2019): (1) Model specification, in which the theoretical model was translated into a path diagram with three exogenous-endogenous relationships and associated measurement models; (2) Model identification, confirmed by a degree-of-freedom value of 87 (120 sample moments minus 33 estimated parameters), establishing the model as over-identified and therefore amenable to fitting; (3) Parameter estimation via Maximum Likelihood Estimation (MLE), which assumes multivariate normality; (4) Model fit evaluation using multiple fit indices, absolute (χ^2, GFI, RMSEA, RMR), incremental (CFI, TLI, NFI, IFI), and parsimony-adjusted (CMIN/df)—following recommended thresholds (Hu & Bentler, 1999); and (5) Hypothesis testing using standardised path coefficients and critical ratios, with significance established at $p < .05$.

For the mediation analysis corresponding to H4, bootstrapping with 5,000 resamples was employed to generate bias-corrected 95% confidence intervals for the indirect effect of instructional leadership on learning quality through pedagogical innovation, as bootstrapping provides more accurate inference for indirect effects than the Sobel test under non-normality (Preacher & Hayes, 2008). Mediation was classified as partial if both the direct and indirect effects were significant, and as full mediation if only the indirect effect remained significant after including the mediator (Baron & Kenny, 1986; Hayes, 2018).

Distributional assumptions were verified before structural analysis. Univariate normality was assessed via skewness and kurtosis statistics (acceptable range: ±2.58 for critical ratios; Kline, 2023). All indicators satisfied this criterion. Multivariate normality was assessed using Mardia's multivariate kurtosis coefficient as implemented in AMOS; the critical ratio value of -0.261 fell within the acceptable range of ±2.58. Multivariate outliers were examined using Mahalanobis distance (D^2); with df = 15 and $p < .001$ threshold of 37.697, the highest D^2 value in the dataset was 30.422 ($p_1 = .010$, $p_2 = .801$), indicating an absence of problematic multivariate outliers.

5 Results

5.1 Respondent Demographics

Table 1 presents the demographic characteristics of the 153 PJOK teacher respondents. The sample was predominantly male (n = 120, 78.4%), consistent with the gender distribution of physical education teachers in Central Java documented by the Ministry of Education and Culture (2022). In terms of teaching experience, the largest group had 1–8 years of service (n = 74, 48.4%), followed by those with 25–32 years (n = 36, 23.5%), 9–16 years (n = 21, 13.7%), 17–24 years (n = 20, 13.1%), and 33–40 years (n = 2, 1.3%). The distribution reflects a bimodal pattern common in Indonesian teacher demographics: a large cohort of early-career teachers recruited under recent expansion programmes alongside a cadre of near-retirement veterans, with implications for professional development strategies.

Table 1 Demographic Characteristics of Respondents (N = 153)

Variable	Category	n (%)
Gender	Male	120 (78.4%)
	Female	33 (21.6%)
Teaching Experience	1–8 years	74 (48.4%)
	9–16 years	21 (13.7%)
	17–24 years	20 (13.1%)
	25–32 years	36 (23.5%)
	33–40 years	2 (1.3%)

5.2 Descriptive Statistics

Descriptive statistics for the three constructs and their indicators are presented in Table 2. Mean scores at the indicator level ranged from 2.77 to 3.27 on a five-point Likert scale, reflecting respondents' generally moderate-to-positive perceptions of instructional leadership, pedagogical innovation, and learning quality in their schools. The construct-level means were: Instructional Leadership (M = 15.57, SD = 3.82, range = 6–24); Pedagogical Innovation (M = 15.61, SD = 3.74, range = 6–25); and Learning Quality (M = 15.32, SD = 3.69, range = 6–24). The proximity of means to the midpoint of the scale is consistent with the regional context, in which initial observations identified moderate levels of instructional leadership practice and pedagogical innovation among PJOK teachers, signalling meaningful room for improvement.

Table 2 Descriptive Statistics for Research Constructs

Construct / Indicator	Mean	SD	Min	Max
Instructional Leadership (X1)	15.57	3.82	6	24
KK1 (Mission definition)	3.27	0.81	1	5
KK2 (Instructional management)	3.14	0.78	1	5
KK3 (Professional development support)	3.09	0.82	1	5
KK4 (Feedback provision)	2.99	0.79	1	5
KK5 (School climate promotion)	3.08	0.83	1	5
Pedagogical Innovation (X2)	15.61	3.74	6	25
IP1 (Method innovation)	3.22	0.77	1	5
IP2 (Technology integration)	3.19	0.80	1	5
IP3 (Contextual adaptation)	3.08	0.76	1	5
IP4 (Assessment innovation)	2.93	0.81	1	5
IP5 (Collaborative learning design)	3.19	0.79	1	5
Learning Quality (Y)	15.32	3.69	6	24
MP1 (Planning quality)	3.11	0.78	1	5
MP2 (Process quality)	3.17	0.80	1	5
MP3 (Evaluation quality)	3.09	0.77	1	5
MP4 (Student-centred engagement)	2.97	0.82	1	5
MP5 (Adaptive instruction)	2.98	0.81	1	5

5.3 Measurement Model: Confirmatory Factor Analysis

Figure 1 and Table 3 presents the CFA results, including standardised factor loadings, AVE, CR, and Cronbach's alpha for each construct. All factor loadings exceeded the minimum threshold of $\lambda \geq .50$ recommended by Hair et al. (2019), with values ranging from .783 to .874, indicating strong indicator reliability. The highest loading indicator for Instructional Leadership was KK1 ($\lambda = .874$), reflecting the centrality of mission-definition behaviours in principals' instructional leadership profiles. For Pedagogical Innovation, IP2 (technology integration) yielded the highest loading ($\lambda = .848$), consistent with the growing salience of digital tools in Indonesian PJOK pedagogy under the Merdeka Curriculum. For Learning Quality, MP4 (student-centred engagement) recorded the highest loading ($\lambda = .860$), affirming the primacy of student-centred practice as the cornerstone of quality instruction.

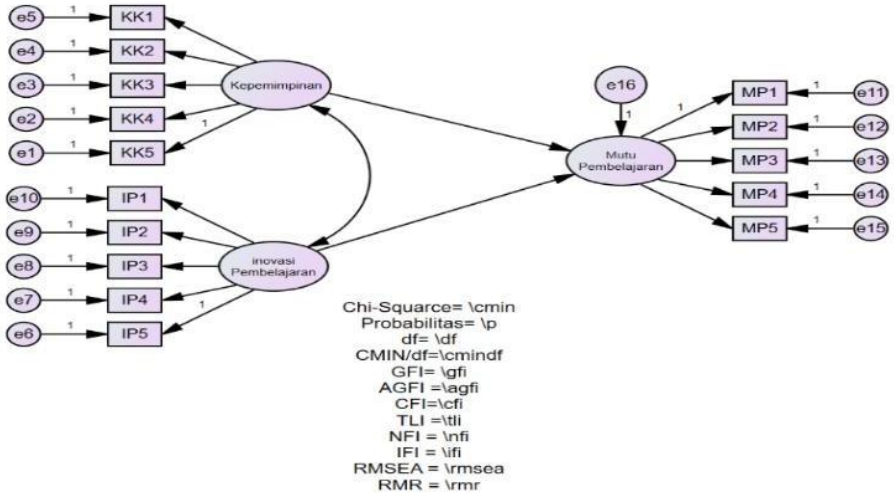

Figure 1 Structural Equation Modelling (SEM) model

Table 3 CFA Results: Factor Loadings, Validity, and Reliability

Construct / Indicator	Λ	AVE	CR	A	Note
Instructional Leadership (X1)	—	.54	.748	.741	Acceptable
KK1	.874				
KK2	.831				
KK3	.816				
KK4	.783				
KK5	.801				
Pedagogical Innovation (X2)	—	.51	.717	.709	Acceptable
IP1	.812				
IP2	.848				
IP3	.796				
IP4	.810				
IP5	.823				
Learning Quality (Y)	—	.57	.738	.731	Acceptable
MP1	.811				
MP2	.832				
MP3	.817				
MP4	.860				
MP5	.808				

Note λ = standardised factor loading; AVE = Average Variance Extracted; CR = Composite Reliability; α = Cronbach's alpha. All loadings significant at $p < .001$.

5.4 Discriminant Validity

The discriminant validity matrix (Table 4) presents inter-construct correlations alongside the square root of AVE (diagonal). Discriminant validity is supported when the diagonal values (√AVE) exceed all off-diagonal correlations in the corresponding row and column (Fornell & Larcker, 1981). Inspection of Table 4 confirms that this criterion is met for all three constructs, providing evidence that the constructs are empirically distinct despite their theoretically hypothesised relationships.

Table 4 Discriminant Validity Matrix (Fornell-Larcker Criterion)

Construct	1. Instructional Leadership	2. Pedagogical Innovation	3. Learning Quality
1. Instructional Leadership	.735		
2. Pedagogical Innovation	.319*	.714	
3. Learning Quality	.412*	.388*	.755

Note Diagonal values (bold) are square roots of AVE; off-diagonal values are inter-construct correlations. *p < .05.

5.5 Structural Model Fit

The goodness-of-fit indices for the structural model are presented in Table 5. The model demonstrated excellent fit across all evaluated indices. The chi-square test was non-significant ($\chi^2 = 85.532$, df = 87, p = .524), indicating that the model-implied covariance matrix did not differ significantly from the observed sample covariance matrix. The CMIN/df ratio of 0.983 fell well below the recommended threshold of 2.00 (Hu & Bentler, 1999). The RMSEA value of .000 and RMR of .027 confirmed minimal approximation error. Incremental fit indices (CFI = 1.000, TLI = 1.001, IFI = 1.001, NFI = .949) all exceeded the .90 threshold. Absolute fit indices GFI = .934 and AGFI = .909 exceeded the .90 criterion. Collectively, these indices provide strong evidence that the specified theoretical model is an excellent representation of the empirical data.

Table 5 Structural Model Goodness-of-Fit Indices

Fit Index	Obtained Value	Recommended Threshold	Assessment
χ^2 (df = 87)	85.532	p > .05	Excellent
p-value	.524	> .05	Excellent
CMIN/df	0.983	< 2.00	Excellent
GFI	.934	≥ .90	Excellent
AGFI	.909	≥ .90	Excellent
CFI	1.000	≥ .90	Excellent
TLI	1.001	≥ .90	Excellent
IFI	1.001	≥ .90	Excellent
NFI	.949	≥ .90	Excellent
RMSEA	.000	< .08	Excellent
RMR	.027	< .05	Excellent

5.6 Structural Path Analysis and Hypothesis Testing

The structural path coefficients, standard errors, critical ratios, and significance levels are presented in Table 6. H1 was supported: instructional leadership exerted a significant positive direct effect on learning quality (β = .212, SE = .084, C.R. = 2.512, p = .012). H2 was supported: pedagogical innovation exerted a significant positive direct effect on learning quality (β = .318, SE = .079, C.R. = 4.044, p < .001). H3 was supported: instructional leadership exerted a significant positive direct effect on pedagogical innovation (β = .319, SE = .096, C.R. = 3.323, p < .001). These path results confirm that each of the three direct pathways in the conceptual model is empirically supported.

Table 6 Structural Path Coefficients and Hypothesis Testing Results

H	Path	Direction	β	SE	C.R.	p	Decision
H1	IL → LQ	Direct	.212	.084	2.512	.012	Supported
H2	PI → LQ	Direct	.318	.079	4.044	< .001	Supported
H3	IL → PI	Direct	.319	.096	3.323	< .001	Supported
H4	IL → PI → LQ	Indirect	.101	.039	—	.003*	Supported

Note IL = Instructional Leadership; PI = Pedagogical Innovation; LQ = Learning Quality; β = standardised path coefficient; SE = standard error; C.R. = critical ratio. *95% bootstrapped CI [.031, .187]. R^2 (Learning Quality) = .313; R^2 (Pedagogical Innovation) = .102.

5.7 Mediation Analysis

To test H4, bootstrapping with 5,000 resamples was employed to estimate the indirect effect of instructional leadership on learning quality through pedagogical innovation. The indirect effect was β = .101 (SE = .039), with a bias-corrected 95% confidence interval of [.031, .187], which excludes zero, confirming statistical significance at p = .003. Since both the direct effect of instructional leadership on learning quality (H1: β = .212, p = .012) and the indirect effect through pedagogical innovation remained significant, the pattern is consistent with partial mediation: pedagogical innovation partially transmits the effect of instructional leadership on learning quality while the principal's direct instructional influence also operates independently. The model explained 31.3% of the variance in learning quality (R^2 = .313) and 10.2% of the variance in pedagogical innovation (R^2 = .102). The total effect of instructional leadership on learning quality was β = .313 (direct .212 + indirect .101).

6 Discussion

6.1 Instructional Leadership and Learning Quality

The significant positive direct effect of instructional leadership on learning quality (β = .212, p = .012) is consistent with the broader body of evidence in instructional leadership research and confirms H1 within the Indonesian physical education context. Hallinger's (2005) model predicts that principals who actively define the school's instructional mission, monitor teaching practice, and create professional learning climates will produce measurable improvements in instructional quality, a prediction that is empirically substantiated in the present study. The magnitude of the effect (β = .212) is modest but meaningful, comparable to the direct effects reported in similar studies in developing country contexts. For instance, Sunariati et al. (2023) reported a path coefficient of .193 for instructional leadership on teacher performance in Indonesian vocational schools, while Aprilianda et al. (2024) found a somewhat larger coefficient of .341, potentially attributable to differences in operationalisation and school type.

An important contextual interpretation concerns the moderate absolute level of instructional leadership quality reflected in the descriptive statistics (mean indicator scores ranging from 2.99 to 3.27 on a five-point scale). This suggests that while instructional leadership is positively associated with learning quality, the overall level of instructional leadership practice in Pati Regency PJOK schools has not yet reached the threshold at which its influence would be maximally felt. This interpretation is consistent with the regional education report card data cited in the study context, which positioned Pati Regency's educational outcomes in an intermediate completion category. It

implies that targeted improvements in principals' instructional leadership capacity could yield disproportionate returns in learning quality—a practical implication elaborated in Section 8.

6.2 Pedagogical Innovation and Learning Quality

The strongest direct predictor of learning quality in the structural model was pedagogical innovation ($\beta = .318$, $p < .001$), supporting H2 and aligning with the physical education innovation literature. Farias et al.'s (2020) findings that innovative instructional models, sport education, cooperative learning, and game-centred approaches significantly outperformed traditional direct instruction in generating student learning outcomes find a structural-level parallel in the present study's results. The prominence of the innovation-quality relationship as the strongest path in the model reinforces Kirk's (2019) argument that pedagogical innovation constitutes a structural prerequisite for quality outcomes in physical education, given the inherent complexity of simultaneously managing physical activity, social interaction, cognitive engagement, and character development objectives.

The indicator-level analysis provides additional interpretive texture. The highest-loading Innovation indicator was IP2 (technology integration, $\lambda = .848$), consistent with the widespread recognition in Indonesian educational policy that digital learning tools are central to the Merdeka Curriculum's vision of twenty-first century pedagogy (Ministry of Education and Culture, 2022). The lowest-loading indicator, IP4 (assessment innovation, $\lambda = .810$), though still robustly loaded, suggests that performance-based and contextual assessment practices, while theoretically valued, may lag behind method and technology innovation in actual classroom implementation. This gap between method and assessment innovation warrants targeted professional development attention.

6.3 Instructional Leadership and Pedagogical Innovation

The significant positive effect of instructional leadership on pedagogical innovation ($\beta = .319$, $p < .001$) supports H3 and provides empirical evidence for the theoretical claim—articulated by Daniëls et al. (2019) and Gkorezis (2016)-that leadership creates the organisational conditions necessary for teacher innovation. Within the Diffusion of Innovation framework proposed by Rogers (2003), the school principal assumes the role of a change agent, facilitating innovation adoption by minimising perceived risk, strengthening perceptions of relative advantage, and ensuring alignment between new instructional practices and the existing professional culture. When instructional leaders model intellectual curiosity, explicitly reward innovative practice, and provide structural supports, time, resources, and collaborative learning opportunities, they accelerate the diffusion of pedagogical innovation through the teacher corps.

The effect size of this path ($\beta = .319$) is notably larger than the direct leadership-quality path ($\beta = .212$), suggesting that leadership's influence on teacher behaviour is more strongly channelled through the creation of an innovation-enabling environment than through direct instructional oversight. This finding has important implications for how instructional leadership is conceptualised and developed: the emphasis should be less on direct supervision and more on organisational climate-building and professional learning support—a distinction that aligns with what Wu et al. (2020) called 'supportive instructional leadership' as distinct from 'directive instructional leadership'.

6.4 Mediation by Pedagogical Innovation

The bootstrapped mediation analysis confirmed that pedagogical innovation partially mediates the relationship between instructional leadership and learning quality (indirect effect = .101, 95% CI [.031, .187], $p = .003$), supporting H4. This partial mediation pattern is theoretically significant because it establishes that instructional leadership affects learning quality through two distinct pathways:a direct pathway through supervision, feedback, and climate management, and an indirect pathway through the enabling of teacher pedagogical innovation. The indirect pathway accounts for approximately 32% of the total leadership effect on learning quality (.101 / .313), making pedagogical innovation a substantively important, not merely marginal, transmission mechanism.

This finding extends Hallinger and Heck's (2010) conceptualisation of mediated effects in instructional leadership research by identifying pedagogical innovation as a specific, measurable mediating mechanism in the PE context. The partial rather than full mediation pattern is also theoretically important: it indicates that principals retain a direct instructional influence on learning quality independent of their innovation-enabling function, so that both pathways,

direct instructional leadership and innovation cultivation, must be simultaneously pursued to maximise learning quality improvement. A principal who excels at innovation support but neglects direct instructional monitoring, or vice versa, will produce suboptimal outcomes.

6.5 Contextual Significance for Indonesian Physical Education

The R^2 value of .313 indicates that the model explains 31.3% of the variance in PJOK learning quality. While this leaves 68.7% of variance attributable to factors beyond the present model, likely including teacher intrinsic motivation, student characteristics, school resources, parental engagement, and broader community factors, the explained variance is comparable to similar studies in education research using SEM (Hallinger et al., 2013).

A contextually significant finding concerns the bimodal distribution of teaching experience in the sample: 48.4% had eight years or fewer of experience, while 23.5% had 25–32 years. These two cohorts likely differ substantially in their receptivity to pedagogical innovation, their relationship with instructional leaders, and their existing levels of learning quality. Future multilevel or moderation analyses examining how experience moderates the leadership-innovation-quality pathways could reveal important nuances that the present aggregate analysis cannot capture.

7 Conclusions

This study examined the structural relationships among instructional leadership, pedagogical innovation, and the quality of PJOK teacher learning in Pati Regency, Indonesia, using covariance-based SEM with a validated measurement model and bootstrapped mediation analysis. All four hypotheses were supported. Instructional leadership exerted significant positive direct effects on both learning quality ($\beta = .212$, $p = .012$) and pedagogical innovation ($\beta = .319$, $p < .001$). Pedagogical innovation exerted a significant positive direct effect on learning quality ($\beta = .318$, $p < .001$). Critically, pedagogical innovation was confirmed as a significant partial mediator of the instructional leadership-learning quality relationship (indirect effect = .101, 95% CI [.031, .187]), accounting for approximately one-third of the total leadership effect on quality. The structural model demonstrated excellent fit across all evaluated indices and explained 31.3% of the variance in learning quality.

These findings make three principal theoretical contributions. First, they extend Hallinger's Instructional Leadership Model by demonstrating that leadership's effect on instructional quality is partially channelled through the activation of teacher pedagogical innovation, a mediating mechanism not previously tested in the physical education domain or in the Indonesian school context using rigorous SEM methodology. Second, they integrate Rogers' Diffusion of Innovation Theory with instructional leadership theory to explain why and how principals enable teacher innovation by functioning as organisational change agents who reduce adoption barriers and create innovation-supportive climates. Third, they contribute empirical evidence from an underrepresented Southeast Asian context to the growing international literature on instructional leadership in emerging educational systems, responding to calls by Hallinger et al. (2013) for geographically diversified instructional leadership research.

Practical Implications

Implications for School Principals

School principals in Pati Regency and comparable Indonesian contexts are encouraged to prioritise explicit instructional leadership behaviours, particularly mission definition, instructional monitoring, and professional climate-building, given that these were empirically found to improve both teacher innovation and learning quality. The finding that the leadership-innovation pathway ($\beta = .319$) was stronger than the direct leadership-quality pathway ($\beta = .212$) suggests that principals will achieve greater learning quality improvement by positioning themselves as enablers of teacher innovation than by functioning primarily as supervisors. Practically, this means creating structured opportunities for PJOK teachers to experiment with new instructional methods, providing protected time for professional learning communities, recognising and publicly celebrating innovative practice, and securing access to digital tools and learning resources.

Implications for Teacher Professional Development

PJOK teachers in the sample demonstrated moderate levels of pedagogical innovation (mean = 15.61 out of 25), with assessment innovation lagging behind method and technology innovation. Professional development programmes should specifically address the full repertoire of pedagogical innovation, including performance-based assessment, differentiated instruction, and game-centred learning models, rather than focusing exclusively on technology adoption, which may be the default innovation orientation. Given the sample's large proportion of early-career teachers (48.4% with ≤8 years of experience), mentoring programmes pairing novice teachers with experienced innovative practitioners could accelerate innovation diffusion.

Implications for Educational Policymakers

The Pati Regency Education and Culture Office and the Ministry of Education and Culture at the national level should translate these findings into concrete policy mechanisms. Selection and performance appraisal criteria for school principals should explicitly incorporate instructional leadership competencies, particularly the capacity to foster pedagogical innovation among teachers. The Merdeka Curriculum's emphasis on deep, contextual, student-centred learning aligns precisely with the pedagogical innovation practices that this study identified as predictors of quality, creating a curriculum-level imperative that policy must support with adequate training, time, and resources.

Implications for Curriculum Developers

Curriculum developers should ensure that PJOK curriculum frameworks provide sufficient flexibility for teacher innovation while maintaining core learning quality standards. Overly prescriptive curriculum designs constrain the instructional creativity that the present study identified as a critical quality driver. Frameworks that specify learning outcomes and quality benchmarks while granting methodological autonomy create the structural conditions most conducive to the type of pedagogical innovation documented here.

Limitations

Several limitations circumscribe the scope and generalisability of these findings. First, the cross-sectional design prevents causal inference in the strict experimental sense; the hypothesised causal sequences are theoretically motivated and structurally consistent with the data but cannot be verified without longitudinal or experimental data. Second, the study is geographically confined to Pati Regency, Central Java, which, while constituting a meaningful and policy-relevant context, may not be representative of the diverse ecological, cultural, and resource conditions across Indonesia's 514 regencies and cities. Third, all data were collected through teachers' self-reports, which are susceptible to social desirability bias, recall error, and common method variance despite the procedural and statistical CMB controls implemented.

Future Research Directions

Several productive research directions flow from the present findings and their limitations. Longitudinal panel designs would enable rigorous testing of the causal sequences posited in the theoretical model, tracking how changes in principal leadership behaviours over time produce lagged effects on teacher innovation and ultimately on learning quality. Mixed-methods extensions, incorporating in-depth principal and teacher interviews, would illuminate the specific mechanisms through which instructional leadership activates pedagogical innovation, moving beyond the structural confirmation provided here to generate explanatory theory. Multilevel SEM designs would permit the simultaneous modelling of between-school variance (attributable to differences in principal leadership) and within-school variance (attributable to individual teacher factors), produce more precise estimates of leadership effects and identify conditions under which they are amplified or attenuated. Cross-national comparative studies, particularly across ASEAN countries with similar Merdeka-type curriculum reforms, would test the transferability of the present model's findings and identify system-level moderators of the leadership-innovation-quality pathways. Finally, future research should expand the outcome variable set to include student-level performance measures, academic

achievement, physical fitness assessments, and affective development indicators, enabling a more complete evaluation of the ultimate student impact of instructional leadership and pedagogical innovation.

Conflict of Interest

The authors declare that there is no conflict of interest.

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