Profit: Jurnal Manajemen, Bisnin dan Akuntansi
Volume 5 Nomor 3 Agustus 2025
e-ISSN: 2963-5292; p-ISSN: 2963-4989, Hal. 286-295
DOI: https://doi.org/10.58192/profit.v5i3.5051
Tersedia: https://journal.unimar-amni.ac.id/index.php/profit

Path Analysis of Teacher Performance as a Mediator of the Effect of Principal Leadership on Student Academic Achievement in Vocational Secondary Schools

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Abstract. This study evaluates and tests the structural relationship model between principal leadership, teacher performance, and student academic achievement at SMK Negeri 2 Medan, by positioning teacher performance as a mediating variable. A quantitative approach with an explanatory survey design was applied to a population of 138 vocational teachers, from which a sample of 103 respondents was selected using simple random sampling. Data on principal leadership and teacher performance were gathered via verified Likert-scale questionnaires, while student achievement data were obtained objectively from official school archives containing aggregated report cards and examination scores. Data were analyzed using multiple linear regression and stepwise path mediation analysis evaluated via the Sobel test within SPSS 25. The results reveal that: (1) principal leadership has a positive and significant effect on student academic achievement (beta = 0.457, $p < 0.05$); (2) principal leadership has a positive and significant effect on teacher performance (beta = 0.551, $p < 0.05$); (3) teacher performance has a positive and significant effect on student achievement (beta = 0.365, $p < 0.05$); and (4) teacher performance significantly acts as a partial mediator in the relationship between principal leadership and student achievement, as the direct impact coefficient significantly declined to 0.305 upon including the mediator in the model. Simultaneously, both independent variables explain 30.7% of the variance in student achievement (R-squar =0.307, F=22,156, p=0.000). This study suggests that educational management should integrate instructional leadership enhancement with teachers' pedagogical professional development to optimize academic outcomes in vocational education institutions.

Keywords: Mediation Analysis; Principal Leadership; Student Academic Achievement; Teacher Performance; Vocational Education.

1. INTRODUCTION

Education represents a fundamental and strategic sector in human resource development, as its quality correlates directly with the caliber of graduates produced by educational institutions. Educational institutions function not merely as vehicles for the transfer of knowledge, but as macro structures that cultivate technical competencies, moral character, and the preparedness of students to confront social dynamics and shifting labor market demands. The 2024 TALIS Report by the OECD asserts that the quality of learning outcomes is heavily conditioned by the effectiveness of teachers' instructional practices, a supportive professional environment, and the quality of school leadership governance (OECD, 2025). Consequently, the substantial acceleration of educational quality relies directly upon the instructional leadership capacity of school principals and the performance accountability of teachers as the frontline of instruction.

In the context of Vocational Secondary Education (SMK), the complexity of quality management escalates because these institutions hold a dual mandate to deliver academic outcomes while simultaneously building vocational competencies synchronized with the

Naskah Masuk: 23 April 2026; Revisi: 16 Mei 2026; Diterima: 28 Juni 2026; Tersedia: 09 Juli 2026

demands of the business and industrial sectors (DUDI). Vocational graduates are required to possess practical expertise, high adaptability, and well-established workforce readiness. In this framework, vocational teachers play a critical role, not only in presenting theoretical constructs but also in conducting applicable, contextualized, and competency-based learning. Empirical studies by Engida et al. (2024) confirm that teachers' instructional quality correlates linearly with student academic achievement; the more refined the instructional delivery, the higher the probability of students securing superior academic outcomes.

Despite the recognized significance of teacher performance, instructional quality frequently exhibits sharp disparities in practice. Preliminary observations at SMK Negeri 2 Medan indicate fluctuations in teacher performance regarding the adoption of educational technology innovations, the precision of assessment methodologies, and the management of a conducive classroom climate. This variation directly impacts the optimal distribution of student academic achievement. This phenomenon strongly indicates that optimization of academic success does not occur mechanically; instead, it is driven by critical antecedent factors, chief among which is the effectiveness of principal leadership.

Theoretically, modern school leadership must shift from an administrative-bureaucratic orientation toward comprehensive instructional leadership. Principals are responsible for articulating an academic vision, coordinating the curriculum, supervising instruction, and facilitating a professional climate that fosters teacher professional development. A meta-meta-analysis by Wu & Shen (2022) concluded that principal leadership has a positive and significant effect on student achievement, with an average effect size of d = 0.34. However, contemporary literature suggests that the impact of principal leadership on student academic outcomes is predominantly indirect, operating through intermediary variables within the internal school ecosystem (Leithwood et al., 2020).

Recent empirical investigations by Papadakis et al. (2024) validate that teacher performance acts as a crucial mediator bridging the influence of leadership for learning on student achievement. Similarly, Persson et al. (2025) demonstrated that teacher collaboration and professional performance mediate the relationship between instructional leadership and pupils' educational attainment. This implies that effective principals enhance student achievement precisely through their ability to intervene, stimulate, and improve the instructional performance capacity of teachers within the classroom (Elfira et al., 2024; He et al., 2024).

While partial correlations between these variables have been widely studied, a significant research gap persists in the literature: integrated structural models positioning teacher performance as a formal mediating variable between principal leadership and student achievement remain relatively under-examined within Indonesian Vocational Secondary Education (SMK). Most existing studies treat teacher performance solely as a final dependent outcome without linking it directly to objective, aggregated student achievement data. Therefore, the novelty of this study lies in testing an integrated structural mediation model connecting principal leadership (X), teacher performance (M), and student academic achievement (Y) using real, school-based data from SMK Negeri 2 Medan. This research aims to map both direct and indirect pathways to provide a theoretical contribution to educational management and a practical foundation for school quality improvement strategies.

2. LITERATURE REVIEW

Principal Leadership

Leadership is conceptualized as a process of social influence whereby an individual stimulates and directs group commitment toward the voluntary and collaborative attainment of organizational goals (Northouse, 2022; Yukl, 2020). In school ecosystems, the principal is a strategic actor with comprehensive responsibility for institutional governance, resource management, and academic quality assurance (Bush, 2020). Drawing on the conceptualization by Hallinger et al. (2025), instructional leadership encompasses three primary dimensions: (1) defining the school's mission collaboratively, (2) managing the instructional program through academic supervision and monitoring student progress, and (3) promoting a positive school learning climate by providing incentives for teachers and fostering a continuous learning culture. Robust leadership transforms structural constraints into innovative opportunities for teaching staff (Daft, 2021).

Teacher Performance

Teacher performance is defined as the manifestation of actual work behaviors displayed by educators in planning, executing, and evaluating the instructional process based on required formal competencies (Robbins & Judge, 2022). In Indonesia, pursuant to Law No. 14 of 2005 concerning Teachers and Lecturers, the theoretical performance standards of teachers are operationalized through four core competencies: pedagogical, professional, social, and personal. Teacher performance is influenced internally by teacher self-efficacy and externally by supervisory support and professional working conditions (OECD, 2025).

Teachers demonstrating high performance accountability are capable of transforming a normative curriculum into active, creative instructional practices oriented toward individual student needs.

Student Academic Achievement

Student academic achievement is the quantitative and qualitative representation of cognitive, affective, and psychomotor behavioral shifts exhibited by learners after completing an instructional process over a specific period (Slavin, 2020). In the vocational school context, the evaluation of student achievement is multidimensional, measuring not only theoretical mastery via written assessments but also the attainment of practical vocational competencies reflected in aggregated report card grades and skills portfolios (Sonda & Nurul, 2021). Student achievement serves as a macro indicator of systemic school success, conditioned simultaneously by input factors (leadership and facilities), process factors (teacher instructional quality), and students' personal characteristics.

Conceptual Framework and Hypotheses Development

The conceptual framework of this study assumes a structural model where principal leadership (X) acts as the predictor variable triggering improvements in teacher performance (M), while both variables simultaneously condition student academic achievement (Y). Based on theoretical synthesis and prior empirical literature, four primary hypotheses are posited:

H1: Principal leadership has a positive and significant effect on student academic achievement at SMK Negeri 2 Medan.

H2: Principal leadership has a positive and significant effect on teacher performance at SMK Negeri 2 Medan.

H3: Teacher performance has a positive and significant effect on student academic achievement at SMK Negeri 2 Medan.

H4: Teacher performance mediates the positive effect of principal leadership on student academic achievement at SMK Negeri 2 Medan.

3. RESEARCH METHODS

This study adopts a quantitative approach utilizing an explanatory survey design to investigate causal relationships and test the proposed structural mediation model. The research was conducted at SMK Negeri 2 Medan, North Sumatra, during the second semester of the 2025/2026 academic year. The target population comprised all 138 permanent teachers actively teaching at SMK Negeri 2 Medan. The sample size was determined using the Slovin formula with a 5% margin of error, yielding a representative sample of 103 teachers. A

simple random sampling technique was employed to ensure the objectivity of scientific generalizations.

Primary data for Principal Leadership (X) and Teacher Performance (M) were gathered via structured questionnaires developed using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The Principal Leadership instrument was operationalized through indicators of vision articulation, instructional supervision, professional development, and quality climate promotion. The Teacher Performance instrument was operationalized through indicators of pedagogical competence (planning and classroom management), professional competence (mastery of vocational content), personal competence (discipline), and social competence (peer collaboration). Pre-testing the instruments among 30 non-sample respondents demonstrated that all items were valid (r-observed > r-table of 0.361) and highly reliable, with Cronbach's Alpha coefficients of 0.892 for variable X and 0.911 for variable M.

Concurrently, data for Student Academic Achievement (Y) were collected through objective secondary sources, specifically official school records consisting of combined average report card grades and final semester examination scores. These scores were aggregated per subject and aligned with the respective teacher to ensure consistency with the teacher-level unit of analysis. Statistical analysis encompassed classical assumption tests (Kolmogorov-Smirnov normality test, VIF multicollinearity test, and scatterplot heteroscedasticity test), followed by multiple linear regression and stepwise path mediation analysis within SPSS 25 to evaluate the mediation type, validated by the Sobel Test.

4. RESULTS AND DISCUSSION

Respondent Characteristics and Descriptive Analysis

The demographic profile of the 103 surveyed teachers indicated a balanced gender distribution: 52 females (50.5%) and 51 males (49.5%). In terms of specialization, vocational/technical track teachers dominated the respondent profile with 37 individuals (35.9%), followed by Language arts (11.7%), Entrepreneurship (10.7%), Religious studies (9.7%), and other science or social tracks. This composition accurately reflects the structural emphasis of SMK Negeri 2 Medan on technical skill development. Descriptive analysis revealed that teachers' perceptions of Principal Leadership fell into the 'Excellent' category (Mean = 4.18), Teacher Performance was categorized as 'Good' (Mean = 4.05), and the objective Student Achievement data showed that the majority (56.31%) scored above the institutional benchmark.

Classical Assumption Testing

Prior to hypothesis testing, statistical prerequisites were verified. The Kolmogorov-Smirnov normality test on residual values yielded a significance value of $p = 0.200$ ($p > 0.05$), indicating a normal distribution. Multicollinearity diagnostics revealed a Tolerance value of 0.696 (> 0.10) and a Variance Inflation Factor (VIF) of 1.436 (< 10), confirming the model is free from multicollinearity. The heteroscedasticity test via a residual scatterplot demonstrated a random dispersion of data points above and below the 0 line on the Y-axis without forming any discernible geometric pattern, satisfying the assumption of homoscedasticity.

Path Analysis and Mediation Testing

The mediation model was evaluated through stepwise linear regression analysis to empirically establish the path coefficients between the constructs:

Model 1 (X predicting Y): Evaluated the direct effect of principal leadership on student achievement without the mediator. The analysis indicated a positive and statistically significant relationship (beta = 0.457; t = 5.162; p = 0.000), thereby supporting Hypothesis 1 (H1).

Model 2 (X predicting M): Evaluated the effect of principal leadership on teacher performance as the mediator. The results revealed a strong and highly significant positive relationship (beta = 0.551; t = 6.612; p = 0.000), validating principal leadership as a robust predictor of teacher performance and supporting Hypothesis 2 (H2).

Model 3 (X and M simultaneously predicting Y): Introduced the mediator, Teacher Performance (M), into the structural model. The analysis demonstrated that Teacher Performance exerted a positive and significant effect on Student Achievement (beta = 0.365; t = 3.421; p = 0.002), supporting Hypothesis 3 (H3). Simultaneously, the direct path coefficient of Principal Leadership (X) on Student Achievement (Y) decreased from beta = 0.457 (in Model 1) to beta = 0.305, yet retained statistical significance (t = 2.864; p = 0.005).

The observed reduction in the direct path coefficient while maintaining statistical significance indicates a pattern of partial mediation. To evaluate the statistical significance of this indirect effect, a Sobel Test was performed using the product of the path coefficients' standard errors. The Sobel Test generated a Z-score of 3.024, exceeding the critical threshold of 1.96 ($Z > 1.96$) with a significance of $p = 0.002$ ($p < 0.05$). Consequently, Hypothesis 4 (H4) is empirically supported, confirming that Teacher Performance functions as a significant mediating variable linking principal leadership with student academic achievement.

Simultaneously, the overall model fit was confirmed via F-test, yielding an F-value of 22.156 ($p = 0.000$). The Coefficient of Determination (R-square) obtained was 0.307. This indicates that 30.7% of the variance in student academic achievement at SMK Negeri 2 Medan is explained by the integrative contribution of principal leadership and teacher performance. The remaining 69.3% is conditioned by external factors outside the scope of this model, such as student intrinsic motivation, parental socioeconomic status, and the quality of laboratory training facilities.

Discussion

The empirical findings of this study provide a logical visualization of how educational management governance operates within school systems. The direct path between principal leadership and student achievement (H1) reinforces the theoretical assertions of Wu & Shen (2022) that macro-level policy directions set by principals provide the initial impetus for establishing academic quality standards. Principals at SMK Negeri 2 Medan who actively extend psychological and material instructional resources effectively trigger higher student learning outcomes.

Regarding the second pathway (H2), the significant impact of leadership on teacher performance underscores the essence of modern instructional leadership. This finding resonates with studies by Elfira et al. (2024) and Werdiningsih et al. (2023), which state that teacher performance is not an isolated, static factor but a dynamic variable responsive to external environmental stimuli. Through consistent academic supervision, the provision of constructive feedback, and the establishment of collaborative professional spaces, the principal successfully elevates teacher self-efficacy and professional competence (He et al., 2024; OECD, 2025).

Furthermore, the positive correlation between teacher performance and academic achievement (H3) validates the role of teachers as the closest operational unit of analysis to student cognition. Teachers who possess pedagogical competence and are adept at linking vocational content with the practical context of the industrial sector (DUDI) deliver engaging instruction, which directly enhances student academic proficiency (Engida et al., 2024; Workala, 2023).

The primary scientific contribution of this study lies in confirming the mediating mechanism of Teacher Performance (H4). This result demonstrates that school principals cannot instantly intervene in student achievement from an administrative desk. The transformative influence of principal leadership policies must first be translated into high-quality teaching behaviors within classrooms. This sequential synergy aligns with the

findings of Papadakis et al. (2024) and Leithwood et al. (2020), wherein leadership effectiveness is channeled through the empowerment of internal school actors (teachers) to generate an optimal impact on student academic outcomes.

5. CONCLUSION AND RECOMMENDATIONS

Based on the data analysis and discussion, the following conclusions are drawn: (1) Principal leadership exerts a positive and statistically significant direct effect on student academic achievement at SMK Negeri 2 Medan. (2) Principal leadership has a positive and significant effect on driving sustainable improvements in teacher performance. (3) Teacher performance has a direct, positive, and significant effect on student academic achievement. (4) Teacher performance functions significantly as a partial mediator in the relationship between principal leadership and student achievement. This confirms that the strategic policies of school principals will yield a substantially stronger impact on student outcomes when manifested through enhanced teaching performance quality within the classroom.

Based on the empirical findings, several practical and theoretical recommendations are formulated: (1) For School Principals: It is recommended to shift leadership paradigms from purely administrative functions to instructional leadership focusing on clinical supervision, industry-based pedagogical mentoring, and providing professional development opportunities for teachers. (2) For Teachers: Educators should continuously maintain professional commitment by enhancing their mastery of instructional technology and designing practical learning modules adaptive to contemporary industrial needs. (3) For Educational Authorities / Department of Education: There is a need to structure integrated school governance regulations wherein principal performance indicators are linked with the effectiveness of teacher competency development programs. (4) For Future Researchers: Given the R-square value of 30.7%, it is suggested to explore other potential variables omitted from this model, such as student intrinsic motivation, parental engagement, digital school climate, and to employ more advanced structural analysis tools such as SEM-AMOS or SmartPLS to broaden scientific generalization.

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