



Leadership for Innovation in Digital Teaching: A Meta-Analysis Review of Principals' Influence on Teachers' Innovative Work Behavior

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Abstract: This study aims to examine the overall effect of principals' leadership on teachers' innovative work behavior, compare the relative strength of different leadership styles, and assess heterogeneity and potential publication bias within the post-2015 digital education context. A meta-analysis of 26 quantitative studies ($k = 26$) indexed in Scopus between 2015 and 2025 was conducted using a random-effects model. The inclusion criteria were: (1) empirical quantitative studies; (2) examination of the relationship between principals' leadership and teachers' innovative work behavior; (3) provision of statistical data convertible into effect sizes; and (4) publication in Scopus-indexed journals. Statistical indicators (r , t , and F values) were converted into standardized effect sizes and analyzed using JASP to estimate pooled effects, heterogeneity indices, and publication bias statistics. The results indicate that (1) there is a very high level of heterogeneity across studies ($I^2 > 98\%$); (2) all leadership styles demonstrate a positive and significant effect on teachers' innovative work behavior ($p < 0.001$), with visionary leadership showing the largest effect size relative to participative, transformational, and ethical leadership styles ($r = 0.641$); and (3) publication bias tests using the Egger test and Fail-safe N reveal no significant indication of publication bias. These findings indicate that principals' leadership is a significant factor in promoting teachers' innovative work behavior in technology-mediated learning environments; however, the magnitude of its impact varies substantially across contextual conditions.

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Introduction

Over the last decade global education has shifted significantly toward technology-mediated learning environments because of accelerated digitalization EdTech ecosystem development and COVID-19 pandemic-related learning system disruption (Honig & Rainey, 2023). Tech integration isn't just support; it's re-wiring teaching itself, pedagogy, design, and school management are all shifting (Fullan, 2001; Redecker & Punie, 2017). Schools now face constant change, demanding structural flexibility and educators' willingness to adapt learning alongside evolving tech (Bond et al., 2020; Fullan, 2001.; Honig & Rainey, 2023).

Technology has changed what teaching actually looks like in practice. Teachers are no longer just expected to know how to use digital tools; they're expected to bring creativity and initiative to their work, trying new approaches, adjusting how they teach, and staying open to experimentation in digital classroom settings (Messmann, 2013; Thurlings et al., 2015). This



matters because technology alone doesn't improve learning. It has to be meaningfully integrated into actual pedagogical practice, not just adopted on the surface (Koh et al., 2017; Liao et al., 2021; Stevens et al., 2024; Tondeur et al., 2012). When schools push for digital adaptation without offering adequate support, teachers often end up burned out, resistant to change, and inclined to use technology as minimally as possible (Day & Gu, 2014; Skaalvik & Skaalvik, 2016).

Among the many factors that influence teacher behavior, the role of the principal stands out. Research suggests that leadership style has a meaningful bearing on whether teachers feel encouraged to innovate or whether they tend to fall back on safer, more predictable routines when digital demands increase (Bush, 2020; Hallinger & Heck, 2010). Transformational, participative, visionary, and ethical leadership have all shown associations with stronger teacher motivation, greater professional confidence, and a higher tolerance for pedagogical risk-taking (Yukl, 2013). Transformational leadership in particular has been found to foster a sense of shared direction and stimulate more creative thinking among teachers (Eyal & Roth, 2011; Leithwood & Sun, 2012; Martínez et al., 2021). Participative leadership contributes in a different but complementary way, drawing teachers into school-level decisions and helping them see innovation as something they collectively own rather than something handed down to them (Bush & Glover, 2014; Hallinger, 2011).

Studies generally support a positive relationship between principal leadership and teacher innovation, though the strength of that relationship varies considerably. (Liao et al., 2021; Martínez et al., 2021; Thurlings et al., 2015). Some report strong correlations while others find moderate or weak effects, particularly when factors like school culture, organizational context, and technology adoption levels are taken into account (Stevens et al., 2024; Tondeur et al., 2012). This variation is also influenced by differences in research design, sample size, and the measurement instruments used to assess teacher innovation (Martínez et al., 2021; Thurlings et al., 2015). The dominance of cross-sectional designs in school leadership research further limits understanding of the stability of leadership effects on teacher innovation over time (Liao et al., 2021; Little, 2024).

The selection of transformational, participative, visionary, and ethical leadership in this study is theoretically grounded in their established relevance to motivational, relational, and value-based dimensions of school leadership. Transformational leadership emphasizes inspiration and intellectual stimulation (Kallapadee et al., 2017); participative leadership highlights shared decision-making and empowerment (Komariah et al., 2023); visionary leadership centers on strategic direction and future orientation (Berkovich & Hassan, 2025); and ethical leadership reinforces trust, fairness, and psychological safety (Qi et al., 2025). Together, these four approaches represent complementary mechanisms through which principals may shape teachers' willingness to engage in innovative work behavior, particularly in contexts characterized by rapid digital change.

To date, no meta-analysis has specifically synthesized quantitative findings on the influence of principals' leadership on teachers' innovative work behavior within technology-mediated learning contexts. Although meta-analytic approaches have been widely applied in educational leadership research (Hallinger & Heck, 2010; Martínez et al., 2021), prior syntheses have generally addressed leadership outcomes in broad organizational or instructional domains without isolating innovative work behavior in digitally intensive environments (Bush, 2020; Leithwood & Sun, 2012). As a result, the unique structural and pedagogical pressures associated with the post-2015 EdTech ecosystem, characterized by rapid digital expansion, platformization of learning, and systemic technology integration, remain insufficiently examined. Existing studies also tend to investigate single leadership



styles in isolation, limiting understanding of their relative effectiveness (Bond et al., 2020; Honig & Rainey, 2023). No study to date has comparatively assessed transformational, participative, visionary, and ethical leadership within a unified meta-analytic framework to determine which dimensions exert stronger influence on teachers' innovative work behavior in digital contexts. This absence of a comparative and context-sensitive synthesis in the post-2015 digital acceleration era leaves a significant gap in the evidence base.

These gaps underscore the urgency of developing a more comprehensive synthesis of empirical evidence to support evidence-based decision-making in school leadership in the digital era. Schools today face real pressure to sustain instructional innovation, and that requires leadership that goes beyond simply responding to technological change. It requires creating a school climate where teachers feel genuinely supported in taking pedagogical risks. Meta-analysis offers a fitting approach to address this need, allowing for a structured examination of effect heterogeneity, a comparison of different leadership styles, and an evaluation of potential publication bias in the existing literature. Based on this, the study pursues three objectives: (1) to examine effect heterogeneity across studies and assess how contextual differences influence the magnitude of leadership effects on teachers' innovative work behavior; (2) to analyze and compare the strength of influence of different principal leadership styles, including transformational, participative, visionary, and ethical leadership, on teachers' innovative work behavior; and (3) to detect and evaluate potential publication bias to ensure that estimated effects are not distorted by a tendency to publish only statistically significant findings.

Research Method

This study used a quantitative meta-analysis design to bring together empirical findings on how principal leadership influences teachers' innovative work behavior. Meta-analysis was the logical choice here given that the relevant studies span multiple countries and educational levels, and report a wide range of statistical indicators including correlation coefficients (r), t -test values, and F -test values. What meta-analysis offers is a structured way to assess the overall direction of the evidence while also accounting for the degree to which differences in research context contribute to variation in findings. This is especially valuable in educational leadership research, where studies accumulate quickly across very different settings.

For a meta-analysis to produce trustworthy results, the criteria for including or excluding studies need to be clearly defined from the outset. Without this, there is no way to ensure that the studies being combined are actually comparable or relevant to the research questions at hand. Clear criteria also make the selection process transparent, so readers can follow the reasoning behind which articles were included. In this study, a study was eligible for inclusion if it met the following conditions: (1) it was a quantitative empirical study examining the relationship or effect of principal leadership on teachers' innovative work behavior; (2) its participants came from formal educational institutions, ranging from kindergarten through to university; (3) it reported sample size (N) along with explicit statistical values for r , t , or F ; (4) it was published in a Scopus-indexed journal, regardless of quartile ranking; and (5) its leadership variable fell under one of four categories: transformational, participative, visionary, or ethical leadership. Studies were excluded if they: (1) were non-empirical in nature, including conceptual papers, qualitative studies, theoretical essays, or literature reviews without quantitative data; (2) did not involve leadership within formal school settings; (3) failed to report r , t , or F values in a form that could be converted into effect sizes; or (4) were published outside Scopus-indexed journals.



The literature search was carried out systematically through the Scopus database using the document search feature. Limiting the search to a single database was a deliberate decision to maintain consistency in indexing quality across all included articles. Searches were run across titles, abstracts, and keywords to maximize relevance to the research focus. Boolean operators AND and OR were used in various combinations to capture the range of terminology authors use when writing about principal leadership, teacher innovation, and technology-mediated learning. Sample search strings included: "*principal leadership*" OR "*school leadership*" OR "*educational leadership*" AND "*innovative work behavior*" OR "*teacher innovative behavior*" OR "*teacher innovation*" AND "*digital learning*" OR "*technology-mediated learning*" OR "*technology integration in education*."

Different studies measure and report their results differently, which is one of the core challenges meta-analysis is designed to address. To handle this, all statistical values drawn from primary studies, whether reported as r , t , or F , were converted into effect size correlations (r), creating a uniform basis for comparison. The standardized effect sizes were then processed through JASP software. This allowed for estimation of the overall pooled effect and an assessment of heterogeneity across the included studies.

The research process started with a broad search of the Scopus database using keywords related to principal leadership, teacher innovative work behavior, and educational contexts. Everything returned by the search was collected and treated as the initial pool of articles. From there, titles and abstracts were reviewed to filter out anything clearly irrelevant, including duplicates and studies that fell outside the scope of educational leadership and teacher innovation. The articles that survived this first round of screening were then read in full. This closer review focused on whether each study actually measured the right variables, reported statistical data in a form that could be converted (r , t , or F), covered a relevant educational level, and provided enough methodological detail to be usable. Studies that did not report effect sizes or did not provide analyzable quantitative data were excluded at this eligibility stage. Based on this stepwise selection process, a total of 26 articles met all inclusion criteria and were designated as primary studies in the meta-analysis. Quantitative data from each included study were systematically extracted, converted into standardized effect sizes, and analyzed using JASP to obtain pooled effect estimates, heterogeneity tests, and visualizations of results.

Results and Discussion

Distribution of Reviewed Articles on Principals' Leadership and Teachers' Innovative Work Behavior

The distribution data of the reviewed articles indicate that academic attention to the influence of principals' leadership on teachers' innovative work behavior has developed gradually in line with the increasing demand for innovation in educational practice. The twenty-six articles analyzed represent diverse research contexts in terms of publication period, educational level, geographical setting, and journal indexation quality. The distribution across educational levels reflects that the issue of leadership and teachers' innovative behavior is considered relevant across levels of education, although the dynamics of innovation challenges differ among primary, secondary, and higher education. Variation in the countries of origin shows that the relationship between principals' leadership and teachers' innovative work behavior is a cross-context phenomenon, yet it remains influenced by national education policies and school organizational culture in each region. The distribution based on journal indexation also indicates that this topic has gained relatively

strong academic legitimacy in reputable literature. Furthermore, the distribution of reviewed articles based on annual development is presented in Figure 1.

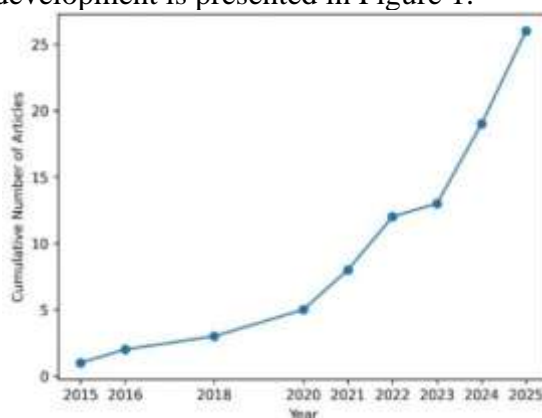


Figure 1. Distribution of reviewed articles based on annual development

Figure 1 illustrates the development of the number of reviewed publications from 2015 to 2025, showing a cumulatively increasing pattern, although the growth rate is not entirely linear. In the early period, the number of publications was relatively limited, with one article each in 2015, 2016, and 2018, indicating that studies on principals' leadership and teachers' innovative work behavior were still in an early exploratory stage. Between 2020 and 2022, published studies grew from two to four. It's a small number, but the timing matters. These years coincided with some of the most disruptive changes schools had faced in decades, and researchers were clearly starting to pay closer attention to what that meant for teacher innovation. By 2024 and 2025, the numbers had climbed to six and seven articles. That shift is hard to ignore. The topic has clearly moved into the mainstream of educational research, no longer treated as a side question but as something worth sustained investigation. Behind this trend is a broader realization that teachers do not innovate in a vacuum. The environment principals create around them has a lot to do with whether innovation actually takes root in schools. Figure 2 shows how the reviewed articles break down by sample characteristics.

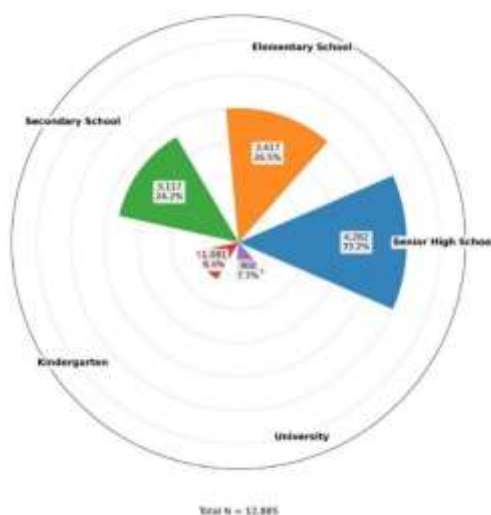


Figure 2. Distribution of reviewed articles based on sample

Figure 2 maps out the sample by school level. Across all included studies, 12,885 respondents participated. Senior High School teachers made up the largest portion at 4,282 respondents (33.2%), while Elementary School contributed 3,417 (26.5%) and Secondary School 3,117 (24.2%). This indicates that leadership and teachers' innovative behavior issues

are most frequently studied at the primary and secondary levels, where the dynamics of school policy implementation and pedagogical innovation tend to be more intensive. Representation at the Kindergarten level (1,081 respondents; 8.4%) and University level (988 respondents; 7.7%) is relatively smaller, suggesting limited research attention to early childhood and higher education contexts in studies of principals' leadership. This pattern shows that the empirical evidence in this meta-analysis predominantly relies on teachers' experiences in primary and secondary schools, thus interpretation of the findings must consider the specific organizational characteristics and work cultures at these levels. Differences in sample proportions across levels also imply variations in leadership contexts that may influence the strength of the relationship between principals' leadership and teachers' innovative behavior. Figure 3 shows where the reviewed articles came from geographically.

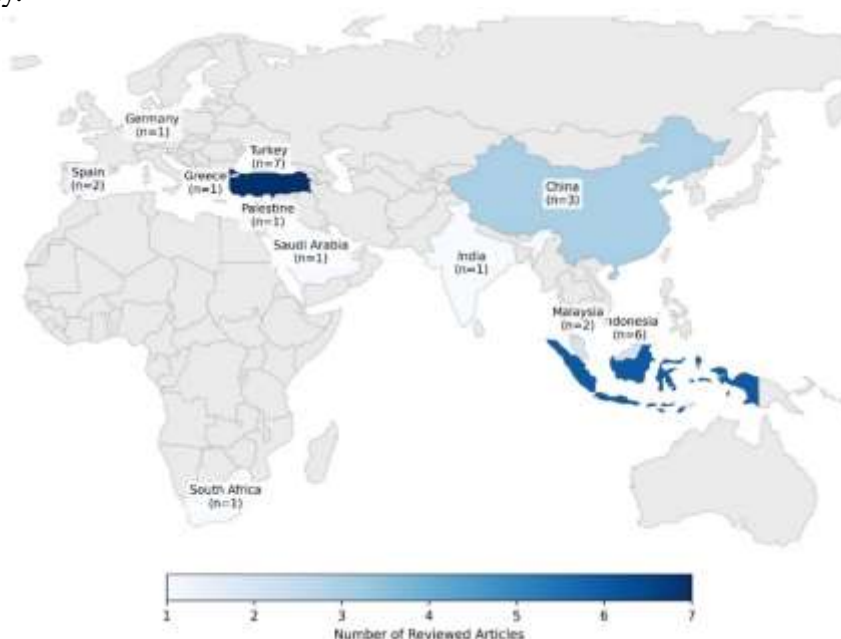


Figure 3. The reviewed articles came from geographically

Not every country is equally represented in Figure 3, and that gap matters. Turkey leads the sample with seven articles, Indonesia follows with six, and after that the numbers fall away sharply. China contributed three, Spain and Malaysia two each, while Germany, Greece, India, Palestine, Saudi Arabia, and South Africa each appear just once in the reviewed literature. On one level this reflects genuine variation in where scholars have chosen to study the link between principal leadership and teacher innovation. On another level it creates an evidence base that leans heavily on a narrow slice of global experience. Findings drawn primarily from Turkish and Indonesian school contexts carry the assumptions and conditions of those settings with them, which means applying them elsewhere requires a degree of caution. Figure 4 addresses how the reviewed articles are distributed across journal indexation categories.

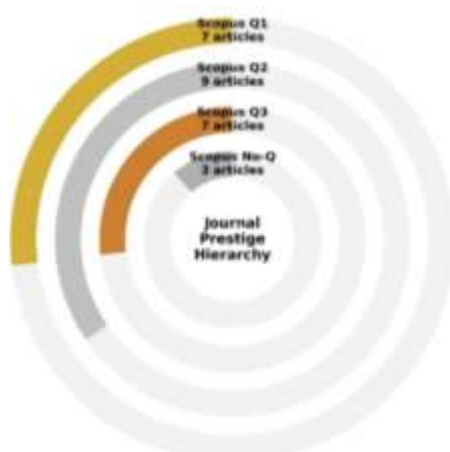


Figure 4. Distribution of reviewed articles based on journal indexing

Figure 4 shows the distribution of reviewed articles by journal indexation category, indicating that most of the analyzed studies were published in mid to high-tier reputable journals. Articles indexed in Scopus Q2 dominate with nine publications, followed by Scopus Q1 and Scopus Q3, each contributing seven articles. Overall, the majority of empirical evidence in this meta-analysis originates from journals within the top three quartiles. The proportion of articles from Scopus No-Q journals is relatively smaller, with three articles, indicating that contributions from journals with lower international visibility exist but do not dominate the dataset. This composition suggests that the methodological quality and credibility of the sources included in this review are relatively well maintained, although variation in quartile ranking may still imply differences in reporting standards and strength of evidence across studies. The distribution of journal indexation also reflects that the theme of principals' leadership and teachers' innovative work behavior has gained considerable attention in reputable journals, rather than being confined to regional publication outlets.

Heterogeneity Test Results of Reviewed Articles on Principals' Leadership and Teachers' Innovative Work Behavior

The heterogeneity test in meta-analysis is used to assess the extent to which variation in effect sizes across studies reflects real differences beyond random fluctuation. Heterogeneity indicators such as τ^2 and τ represent the magnitude of between-study variance in effect size units, while I^2 and H^2 indicate the proportion of total variance attributable to real differences among studies. A summary of the heterogeneity test results is presented in Table 1.

Table 1. Heterogeneity test results

Leadership	k	τ^2	τ	I^2 (%)	H^2	Interpretation
TL	11	0.699	0.836	99.590	243.859	Very high heterogeneity
PL	9	0.116	0.340	98.380	61.747	Very high heterogeneity
VL	12	0.311	0.558	99.518	207.512	Very high heterogeneity
EL	4	0.207	0.454	98.070	51.836	Very high heterogeneity

The heterogeneity test results in Table 1 show that all leadership categories exhibit very high heterogeneity, as reflected by I^2 values above 98% for transformational (TL), participative (PL), visionary (VL), and ethical leadership (EL). The relatively large τ^2 and τ values across all categories indicate substantial between-study variance in effect size estimates, meaning that differences in findings cannot be explained by sampling error alone. H^2 values far above one further confirm that the variability across studies greatly exceeds what would be expected if all studies were estimating the same true effect.

Researchers cannot attribute the very high heterogeneity in this meta-analysis purely to sampling error. Something more substantive is at work: research contexts genuinely shape how leadership effects manifest, and the variation across studies reflects that. Most meta-analysts interpret I^2 values at or above 75% as confirmation that true between-study differences, not random variation, drive the bulk of effect size variability (Borenstein, 2023). Differences in populations, methodologies, and research settings naturally generate this kind of spread, and scholars broadly accept heterogeneity as something meta-analyses will inevitably encounter rather than something requiring correction (Choi & Kang, 2025). Contextual differences must therefore factor into any interpretation of the pooled results. The random-effects model produces τ^2 and τ statistics that illustrate this point directly: true effects scatter widely across the reviewed studies, and the unique characteristics of each research context determine what leadership effects look like within it. Carrying findings from one context over to another without accounting for those characteristics would not be analytically defensible (Migliavaca et al., 2022).

Effect Size Test Results of Reviewed Articles on Principals' Leadership and Teachers' Innovative Work Behavior

Across the studies reviewed, researchers cannot treat the influence of principal leadership on teachers' innovative work behavior as a fixed quantity. Effect sizes vary, and the heterogeneity test confirmed just how much, with I^2 values surpassing 98%. That figure made model selection straightforward. The random-effects model is what the data calls for under conditions like these, precisely because it does not force a single true effect size onto studies that clearly differ from one another. Differences in research context, sample characteristics, and study design all contribute to genuine variation in effects, and this model accommodates that reality rather than smoothing over it. What the pooled estimate represents here is therefore the average of a distribution of effects across varying conditions, not a universal value that applies equally to every setting. For a body of literature as contextually diverse as this one, that distinction matters considerably.

Table 2. Effect size test results

Leadership	Estimate (r)	Std. Error	z	p	95% CI	Interpretation
TL	0.527	0.065	8.139	< 0.001	[0.400, 0.654]	Moderate effect
PL	0.598	0.058	10.314	< 0.001	[0.485, 0.701]	Moderate effect
VL	0.641	0.062	10.339	< 0.001	[0.520, 0.744]	Large effect
EL	0.425	0.071	5.986	< 0.001	[0.286, 0.554]	Moderate effect

Principals' leadership style matters for teacher innovation, and Table 2 makes that clear. All four leadership types produced positive and significant effects on teachers' innovative work behavior ($p < 0.001$), though the mechanisms behind those effects and their relative strengths differ in ways worth examining carefully. Visionary leadership is where researchers find the strongest result ($r = 0.641$), a large effect by Cohen's criteria. Teachers appear to respond to leaders who articulate a clear direction and frame innovation as something the school pursues collectively, making experimentation feel purposeful rather than professionally risky. Participative leadership produced the next strongest effect ($r = 0.598$), falling within the moderate category. Decision-making processes that genuinely include teachers seem to shift how innovation is experienced, turning it from an administrative expectation into something teachers feel they had a hand in shaping. Transformational leadership recorded a moderate effect as well ($r = 0.527$). Inspiration and motivational support from principals can drive meaningful change, but the data suggests this works best when leaders also demonstrate practical tolerance for new ideas and the

occasional failure they bring. Ethical leadership showed the smallest effect among the four ($r = 0.425$), though it remained comfortably within the moderate range. Fairness, integrity, and consistent moral conduct from a principal appear to build the kind of psychological safety that teachers need before innovation feels like a reasonable professional risk. Each leadership style, in other words, contributes to teacher innovation through its own distinct pathway.

When the random-effects model is applied across all four leadership types, the results consistently point in the same direction: principal leadership positively and significantly shapes teachers' innovative work behavior (IWB). Social exchange theory and self-determination theory offer a useful theoretical lens for understanding this pattern, both frameworks highlighting how work meaning, autonomy, and contextual support create the conditions under which innovative behavior tends to flourish. Research by (Bao, 2024) illustrates this dynamic concretely, finding that transformational leadership reaches teachers' innovative behavior through the mediation of sense of meaning at work, a pathway that builds intrinsic motivation and lowers the perceived risk of trying something new. Furthermore, (Hsieh et al., 2024) found that distributed leadership and instructional leadership are significantly correlated with teacher innovation through increased self-efficacy and organizational support. The findings of (Lu et al., 2025) also demonstrate that principals' authentic leadership enhances teachers' innovative work behavior through the mechanisms of perceived insider status and psychological well-being. In addition, (Hidayat & Patras, 2022) proved that principals' leadership and learning organization directly contribute to the improvement of teachers' innovative work behavior, particularly in the context of educational change. (Almessabi, 2025) further confirmed that supportive and visionary principals' leadership behaviors are significantly associated with increased teachers' innovative work behavior.

Publication Bias Test Results of Reviewed Articles on Principals' Leadership and Teachers' Innovative Work Behavior

Publication bias analysis in meta-analysis ensures that pooled effect estimates are not distorted by a tendency to publish significant results more frequently than non-significant ones. In this study, publication bias was assessed using three complementary approaches statistical asymmetry testing using the Egger test and robustness evaluation through Fail-safe N. The detailed results of these analyses are presented in Tables 3 and 4.

Table 3. Egger test results

Leadership	z	p	Publication Bias
TL	0.591	0.555	Not detected
PL	1.823	0.068	Not detected
VL	0.118	0.906	Not detected
EL	0.514	0.607	Not detected

Table 4. Fail-safe N results

Leadership	Fail-safe N (Rosenthal)	Target Significance	Observed Significance	Threshold (5k + 10)	Interpretation
TL	608	0.050	< 0.001	65	Robust against publication bias
PL	421	0.050	< 0.001	55	Robust against publication bias
VL	1,203	0.050	< 0.001	70	Highly robust against publication bias
EL	148	0.050	< 0.001	30	Robust against publication bias

Publication bias was assessed using Egger's regression test and the Fail-safe N approach. Across all leadership categories, Egger's test produced non-significant results ($p > 0.05$), indicating no statistical evidence of asymmetry. Furthermore, the Fail-safe N values



substantially exceeded the tolerance threshold ($5k + 10$), suggesting that a large number of null-result studies would be required to invalidate the observed significance. Together, these findings indicate that the meta-analytic estimates are statistically robust and unlikely to be substantially influenced by selective publication. Therefore, it can be concluded that the results of this meta-analysis can be considered sufficiently robust against potential publication bias, so that the pooled effect size obtained has an adequate level of reliability to serve as a basis for scientific interpretation and practical implications.

The results of the publication bias test indicate that the estimated effect of principals' leadership on teachers' innovative work behavior (IWB) can be considered sufficiently reliable, as no indication of publication distortion was found, through the Egger test results with all p-values above 0.05. Methodologically, this condition indicates the absence of systematic small-study effects, as explained in recent meta-analytic literature (Lin et al., 2020), suggesting that the relationship between leadership and teacher innovation is not merely influenced by the tendency to publish significant findings (Page et al., 2021). Publication bias is another concern that the data addresses directly. Fail-safe N values across all four leadership types far exceed the standard threshold of $5k + 10$, with visionary leadership producing particularly large figures. Even under the assumption that a substantial number of null-result studies went unpublished, the significance of these findings holds. What that means, practically speaking, is that the influence of principal leadership on teachers' innovative work behavior is not a statistical artifact produced by selective publication. It is a pattern that holds up across studies and contexts with reasonable consistency. Findings of this kind lend considerable support to modern leadership theories that place inspirational, participative, moral, and visionary dimensions at the center of school innovation culture (Yang & Berdine, 2021; Zhang et al., 2021).

Conclusion

Based on the results of the meta-analysis, it can be concluded that: (1) the heterogeneity test indicates a very high level of heterogeneity across studies, suggesting that the magnitude of the effect of principals' leadership on teachers' innovative work behavior varies substantially and is influenced by differences in research contexts, such as educational level, country, school organizational characteristics, and methodological approaches used; (2) all types of principals' leadership have a positive and significant effect on teachers' innovative work behavior, with visionary leadership showing the largest effect size, followed by participative and transformational leadership, while ethical leadership still provides a meaningful influence although with relatively more moderate effect strength; (3) the results of the publication bias tests through Egger test, and Fail-safe N indicate no significant publication bias, so the estimated effect of principals' leadership on teachers' innovative work behavior can be considered sufficiently stable and not distorted by the tendency to publish significant findings.

These findings suggest that strengthening school leadership is not merely a managerial concern but a strategic lever for sustaining innovation in digital teaching environments. In particular, the comparatively stronger role of visionary and participative leadership highlights the importance of clear strategic direction and meaningful teacher involvement in fostering innovative practices. For policymakers and leadership training providers, this implies the need to design professional development programs that cultivate digital vision-building, collaborative decision-making, and innovation-oriented school cultures. Leadership certification, continuous professional development, and recruitment systems may benefit from integrating competency profiling aligned with transformational,



participative, and ethical dimensions. By doing so, education systems can move beyond reactive digital adaptation toward more sustainable and systematically supported innovation.

Recommendation

This meta-analysis is predominantly based on cross-sectional studies and is geographically concentrated in a limited number of national contexts, particularly Turkey and Indonesia. Such concentration may influence the magnitude and pattern of the observed leadership effects, as educational governance structures, cultural norms, and levels of digital integration differ substantially across countries. Therefore, the generalization of these findings to other global contexts should be approached with caution. The high heterogeneity across studies further suggests that contextual factors, including national policy frameworks, institutional readiness, and technological infrastructure, may moderate the relationship between principals' leadership and teachers' innovative work behavior. Future research is encouraged to expand geographical representation, incorporate longitudinal or quasi-experimental designs, and examine cross-national moderator variables to enhance the external validity and theoretical refinement of leadership–innovation models in digitally evolving educational systems.

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